POWER

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PHILIP W. SWAIN, *Editor*

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NOISE IS NEXT

• WORKABILITY CAME FIRST. In the early days the sole concern was to build machines to "do the job." Reliability, good appearance and efficiency came later.

• THE INDUSTRIAL ENVIRONMENT has made great progress in cleanliness—clean machines, clean rooms, clean air. And in illumination. These things, desirable also for higher reasons, are now sought because they pay dollar dividends.

• BUT THERE STILL REMAINS A GREAT FIELD to conquer. Why so much racket to get the world's work done?

• AFTER DECADES OF STUDY by the best engineering minds, steam shovels still rip the air as well as the earth, although mufflers are cheap. The newest subway trains roar like the front-line trenches. Have their designers never heard that there is a well-developed science of acoustics?

• IN MANY POWER PLANTS, noisy turbines, gears, high-speed auxiliaries, coal crushers and reducing valves hinder intelligent operation.

• OPERATORS AND DESIGNERS alike seem to take all this noise for granted, as something inevitable like death and taxes. But is it? Isn't it just another example of human inertia?

• IN THE BOILER ROOM of thirty years ago, heat, dirt, overwork and darkness held the same position until the human "stoker" became the very symbol of sweating humanity. Those conditions, too, were accepted as inevitable; the great engineering talent that developed the steam boiler and the steam engine was not thought competent to eliminate them.

• BUT IT HAS. The modern boiler room is clean, light, peaceful—a place where men can work and **think.** And because it is such it attracts men of quality and inspires them to apply their brains to the problems of operation.

• WHAT ARE THE RESULTS? More civilized industrial relations. A life worth living for the men in the plant. Literally millions of dollars saved to owners because alert operators plug dollar leaks of every sort.

• YET NOISE REMAINS, reduced but not yet conquered. Industry has still to learn the true value of quiet. Owners even today do not demand silence in machines as they demand output, reliability and efficiency—clean plant, clean air, good light.

• BUT IT'S COMING. Already the domestic consumer has achieved his demand for quiet sewing machines and refrigerators, quiet automobiles. The industrial consumer comes next. When he discovers that noise means dollar losses as well as human waste, he will specify quiet machines. And he will get them, because today's designing engineers can eliminate most machine noises if they put their minds to the job.

• "ANOTHER FRILL" it seems now to some. But when it arrives, they will discover a new necessity.

"TELL 'EM"

WINTER CONVENTIONS are not far off. Already engineers have started work on papers for the annual meetings of the A.S.M.E. and other engineering societies. Presumably all of these papers will present results of practical value to somebody. Yet many a paper will fall short of its possibilities because the author fails to keep his eye on the ball.

In writing a technical paper the author should ask himself three questions: "Is this something that a lot of readers or listeners will want to know? Is it correct and valuable information? Do I tell what they want to know without beating around the bush?

DRAMATIZING STEAM FLOW

FOR YEARS electrical engineers have been decorating distribution switchboards with dummy bus structures in miniature. The idea, of course, is to reduce costly and dangerous errors by letting the operator "see" what he is doing. Now comes the steam-flow hook-up in copper (see page 508). The Anheuser-Busch flow-meter board neatly fits ten actual flow meters into a clean-cut line diagram made of copper bars with polished plates cut out to simulate boilers, turbines, heaters and condensers.

We think that Anheuser-Busch has started something. The idea is sound. It should be widely applied in plants where operation requires wide-awake supervision of a complete steam hookup.

FINISH THE JOB!

WHEN THE BIG American program of steam research started sixteen years ago, the projected work in the field of high pressures and temperatures seemed away ahead of practice. But practice took such a spurt results came barely in time to serve designers.

The whole program has been a marvelous example of precise research, more difficult than the layman could imagine. It is nearly complete. Already the Bureau of Standards has extended its saturation measurements from freezing to the critical point. The only remaining job is to check by calorimeter the previous indirect measurements in the superheat region. A few thousand dollars will finsh the work, which lack of funds threatens to halt. S.O.S. for an "angel"—one or many—to chisel the final word in this cornerstone of all future steam engineering!

WROUGHT-IRON STACKS

HERE'S ONE CASE where the more costly material is cheaper. On the mill floor wrought iron costs eighty per cent more than steel. Erected as an unlined smoke stack, it runs the cost up an average of 30 per cent over steel.

But consider *yearly* cost. The available records show an average life five times as great for wrought iron—36 years instead of seven. Thus a $1,000 stack lasts seven years and a $1,300 stack 36 years. Without interest the steel stack costs $143 yearly, the iron stack $36. But interest exists and must be considered, so let's refigure the yearly cost on the basis of a sinking fund compounded at 6 per cent. On this basis the steel stack costs $179 per year, the iron stack $89.

But perhaps the owner is not interested in 36-year life—expects to replace the whole plant before that. Then he can figure (again on a sinking-fund basis) that iron is cheaper for any life over 9½ years.

SMALL-UNIT DIESEL PLANTS

POWER'S pages have recently seen some lively arguments on the proposition that many small diesels might make a better plant (cheaper and less costly to operate) than a few large engines. The proposal hinges on a fact and a probability—the fact that the small diesel is nearly as efficient as the large—the probability that quantity production of small engines may make them much cheaper than the large per horsepower. It is expected that the growing demand for diesels to operate busses, trucks and boats will lead some manufacturers to apply automobile manufacturing methods to some of the small sizes. If this happens the multiple-unit plant may have the following advantages: less excess capacity; lower first cost; equal efficiency (partly because of better loading of operating units); standardization of routine repair and maintenance; elimination of emergency repair and maintenance.

Objections offered are: complex piping; complex and costly electrical equipment; electrical operating difficulties. One suggested way out of electrical difficulties is the use of special induction generators, permitting units of slightly different speeds to run in parallel (see page 463, August *Power*).

The basic idea of the many-small-unit diesel plant bucks the whole trend of modern steam practice and is instinctively opposed by most engineers. Yet there may be something in it.

POWER STANDS FOR

1. Making power when it should be made
2. Buying power when it should be bought
3. Cheaper power through modern equipment
4. Easier financing of equipment purchases
5. Better use of by-product heat and power
6. Operating methods that save money
7. Less waste in transmission and application
8. Prevention of smoke, within reason

POWER FOR TWO COTTON MILLS FROM ONE PLANT

New capacity of 6,000-kw. installed in old power plant building

By GUY MANKIN

Clinton Cotton Mills' new power plant operates on steam at 400 lb. pressure generated in a boiler of radical design. Plant also supplies power to Lydia Cotton Mill three miles away

CLINTON Cotton Mills, Clinton, S. C., has recently constructed a 5,000-kw. plant, operating at 400 lb. pressure, which in addition to supplying power and steam for the Clinton Mills, also supplies power to the Lydia Cotton Mills about three miles away. During the 16-hr. day that these mills are in operation, average hourly plant load runs about 3,700 kw., with a net output to the cotton mills of a little over 3,500 kw. Steam production averages somewhat less than 50,000 lb. per hr., of which about 18 per cent is bled to mill process. Plant load during the remaining 8 hr. is much lighter and is carried by a small turbine.

Under these conditions, the plant is operating with an over-all coal rate of 1.2 lb. per net kw.-hr., or about 17,200 B.t.u. per net kw.-hr. as derived from the actual daily coal rate obtained from coal scale and meter readings. This covers the entire 24 hr. of operation and includes coal required for process steam used in the Clinton Mills.

The accompanying heat-balance diagram details the heat-flow quantities at various points throughout the system. It is based on the normal day load of 3,700 kw. and shows a net cost rate of 1.1 lb. per kw.-hr., which is just about the actual measured consumption for this portion of the day.

When compared with the usual power plant found in southern textile mills this plant shows many innovations, such as boilers operating at 400 lb. and at high superheat, turbines operating condensing with two stages of bleeding, closed feed-water heating and evaporated makeup. But by careful design, its actual installed cost was amply low, making it an attractive investment.

The plant is housed in existing buildings which required some modification. Equipment and floors were removed, the basement was excavated and new floors were poured in the turbine room. Because of its age and poor condition, the boiler house roof was completely rebuilt.

Mechanically, the plant is characterized by its simplicity and directness. Duplicate equipment has been used only where strictly essential.

Coal is received by railroad, and cars are dumped into a track hopper. A belt conveyor carries the coal from the hopper bottom to the boot of a bucket elevator. At the end of the conveyor a magnetic pulley separates out tramp iron.

Storage is provided in a reinforced tile silo. A section at the top of the silo, into which the elevator discharges, is formed by a sloping bottom and provides 90 tons of live storage. Coal from this live storage falls by gravity into an automatic weigh scale which discharges into chutes to pulverizers.

When this live-storage section is filled, the coal overflows into the rest of the silo which provides a reclaiming storage of 135 tons. Another sloping bottom allows this stored coal to be fed back into the

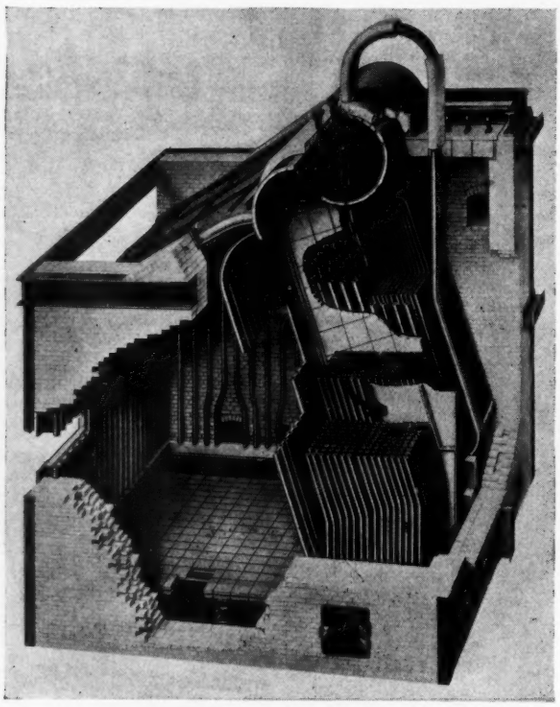


Fig. 1—Integral furnace boiler with gas flow as shown by arrows

elevator and returned to live storage when necessary.

Steam is generated in two boilers at 400 lb. pressure and 725 deg. temperature. Each has a maximum capacity of 40,000 lb. per hr. The boilers are set in battery with their respective drums parallel to each other and a common back wall between. Individual exit dampers lead to a common breeching connected to a 175-ft. brick stack.

Each boiler is direct fired by one ball-type unit pulverizer through a 12-in. circular forced-draft burner in the end wall of the furnace. A third pulverizer, 0.75 tons capacity, is arranged with a swinging coal pipe to fire either of the boiler units through a 7-in. circular natural-draft burner below the main burner of each boiler. This auxiliary pulverizer is used for light loads when the small turbine is in service. Pulverizers are motor driven through a V-belt transmission, run at constant speed. Coal firing rate is controlled by remote adjustment of D.C. motor-driven rotary feeders.

New Arrangement of Gas Flow In Boilers

The two boilers and furnace units are new in design and represent a radical departure from the usual boiler unit. They are two-drum, inclined-tube, three-pass type. Furnace gas enters the tube bank at the far end of the furnace, passes through a slag screen, a first bank of 3½-in. tubes on comparatively wide centers and through a large superheater. The gas then turns into two passes of 2-in. tubes on closer centers. Flow, in general, follows the length of the boiler drums, and the gas leaves the boiler at the top of the opposite end of the tube bank from that at which it entered.

This flow arrangement with its first pass across the whole width of the furnace and gas flow proceeding backward over vertically-inclined baffles, is shown in Fig. 1. It makes possible greater tube surface in a limited space and gives longer gas travel than would have been possible with the usual type boiler occupying the same space. Both features make for a more thorough removal of heat from the furnace gas and thus improve boiler efficiency.

Likewise, with this construction, the furnace runs the whole length of the tube bank and this allows the long flame travel and adequate furnace volume necessary for complete combustion while still maintaining the low-head room and limited space usually required in industrial installations.

Except for the burner walls the furnaces are completely water cooled. Side walls are of stud-tube construction with refractory between the tubes. The tubes of the sidewall opposite the boiler rise vertically for the

Principal Equipment Clinton Cotton Mills Power Plant

General

Boiler steaming capacity ..... 65,000 lb. per hr.
Generating capacity ..... 6,000 kw.
Steam pressure ..... 400 lb. per sq.in.
Steam temperature ..... 725 deg.
Location ..... Clinton, S. C.

Coal and Ash Handling

Coal conveyor, 30 ton per hr. ..... Fairfield Engineering Co.
Coal storage silo, 16 ft. dia. 55 ft. high, 90-ton live storage, 135-ton dead storage.
Weigh scales ..... Richardson Scale Co.
Pulverizers, integral primary air fans, 2 size 126, 1-size 114 ..... Babcock & Wilcox Co.
Burners, one 12 in. and one 7 in. dia. per boiler ..... Babcock & Wilcox Co.
Hydro-jet ash-handling system ..... Allen-Sherman-Hoff Co.

Boilers and Auxiliaries

Boilers, 2-bent tube 2-drum 4,673 sq.ft. heater surface, 400 lb. pressure ..... Babcock & Wilcox Co.
Superheaters, inverted type 725 deg. temperature ..... Babcock & Wilcox Co.
Furnace, volume 1,700 cu.ft. side wall, back wall and floor water cooled ..... Babcock & Wilcox Co.
Soot blowers ..... Diamond Power Specialty Corp.
Forced-draft fans, 2-40,000 c.f.m. at 6½-in. s.p.
Primary air heaters, one each pulverizer ..... Aerofin Corp.
Stack, common brick, 7 ft. dia. 175 ft. high
Feed-water regulators ..... Swartwout Co.

Generating Units and Auxiliaries

Turbine-generators, 1-5,000 kw., 1-1,000 kw., 3,600 r.p.m. 2,400 V, 3 phase, 60 cycle, Steam pressure. 375 lb. 725 deg. extraction at 65 and 15 lb. on large unit and 15 lb. on small ..... General Electric Co.
Generator Air Cooler ..... General Electric Co.
Condensers, 2 pass, one-6,400 sq.ft. one-1,295 sq.ft. ..... C. H. Wheeler Mfg. Co.
Circulating Water pumps, 1-7050 gpm. 1-1560 g.p.m. motor-driven ..... C. H. Wheeler Mfg. Co.
Condensate pumps, 1-155 g.p.m., 1-30 g.p.m. 70 ft. head, motor-driven ..... C. H. Wheeler Mfg. Co.
Air removal, 2 steam jets with inter and after condensers ..... C. H. Wheeler Mfg. Co.

Feed-Water Heaters

Deaerating heater, 80,000 lb. per hr. 15 lb. per sq.in. working pressure ..... Cochrane Corp.
High-pressure heater, 2 pass condenser type, 65,000 lb. per hr. ..... Griscom-Russell Co.
Evaporator, 4,000 lb. per hr., vertical bent-tube ..... Griscom-Russell Co.
Evaporator condenser, 2-pass ..... Griscom-Russell Co.
Boiler feed pumps, 2-150 g.p.m., 1,000 ft. lead, one motor, one turbine drive, 3,600 r.p.m. Allis-Chalmers Mfg. Co.
Make-up pump 75 g.p.m. 60 ft. head 212 deg. F. water ..... Ingersoll-Rand Co.

Piping and Valves

Piping contractor ..... Crawford & Slaten Co.
Steam header, all welded.
Check gate and globe valves ..... Chapman Valve Mfg. Co.
Atmospheric relief valve ..... Atwood & Morrill Co.
Regulating valves ..... Swartwout Co.
Non-return valves ..... Edwards Valve & Mfg. Co.
Reverse flow valves ..... Atwood & Morrill Co.
Back-pressure relief valve ..... Foster Engineering Co.
Small valves ..... Consolidated Ashcroft Hancock Co.
Traps ..... Armstrong Machine Works
Drainers ..... Griscom-Russell Co.
Pipe covering 85% magnesia ..... Johns-Manville Co.

Miscellaneous

Flow Meters ..... Bailey Meter Co.
Draft gages and regulators ..... Bailey Meter Co.
Recording pressure gages ..... Bailey Meter Co.
Indicating pressure and vacuum gages and thermometers ..... Consolidated Ashcroft Hancock Co.
Motor generator set, one-5-kw. Switch board, 5 steel panels ..... General Electric Co.
Electrical Contractor ..... Huntington & Cuerry, Inc.

height of the furnace then slope across to the upper boiler drum to form the roof of the furnace. The rear wall is cooled by bare tubes, while the furnace floor is composed of bare iron-block-covered tubes, which extend to an ash pit at the rear of the furnace.

Primary air is preheated in fin-type radiator heating elements using steam at 65-lb. pressure. Secondary air is supplied by two motor-driven fans through underfloor ducts to the burners and is not preheated. The volume of secondary air is controlled by a compressed-air-operated segmental damper mechanism on the suction side of each fan. This mechanism is remotely controlled from the boiler operating panel. Instruments and controls necessary for regulation of boiler operation are concentrated on a single panel in front of and between the boilers. Boiler meters and pressure gages are provided for each boiler, as well as a multi pointer draft gage. A recording pressure gage, connected to the main steam header, gives a continuous record of steam pressure. Stack damper and secondary air flow may be adjusted manually from the boiler panel by means of remote controls which are operated on compressed air.

Normal operating loads are carried on a 5,000-kw. turbo-generator which operates condensing with steam bled at 65 lb. for mill process and high-pressure heating. Steam bled at 15 lb. supplies the plant makeup evaporator and low-pressure heating. A 1,000-kw. machine, also condensing, and bled at 15 lb. for plant use only, carries the light loads applying when the cotton mills are not in full operation.

These turbines are impulse type, operating on 375-lb. pressure and 725-deg. steam. With the normal day load of 3,700 kw. and operating on 27½ in. vacuum, the steam rate, with no bleeding, is slightly over 10 lb. per kw.-hr.

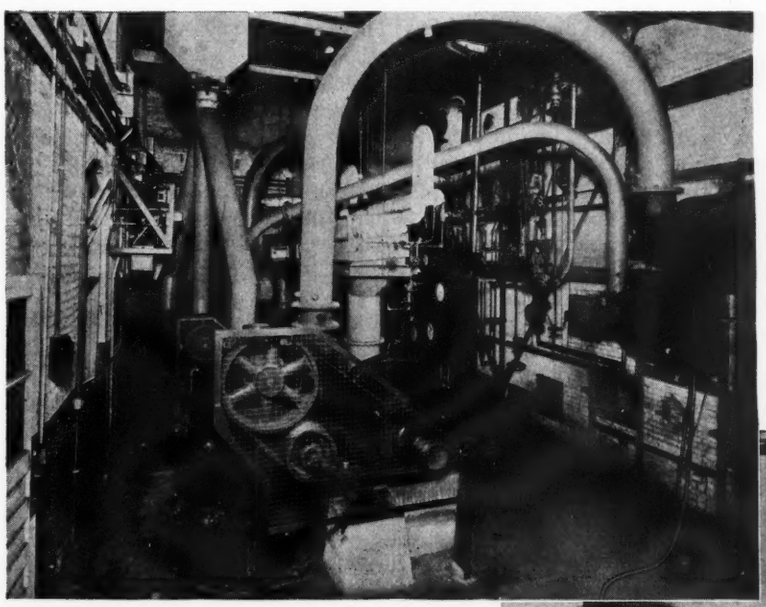
One condensate and one circulating pump, motor driven, are provided for each condenser. Circulating water is cooled in a spray pond of 172 spray heads. The spray piping system is divided into three equal sections, the middle section being used when only the 1,000-kw. unit is in service.

Non-Automatic Bleeder Mechanism

Bleeders are not automatic and pressures are maintained by reducing valves. If pressure drops in the 15-lb. line, a reducing valve (in a tie line between the 15-lb. and the 65-lb. lines) admits steam to the lower-pressure line to hold its pressure. If pressure drops in the main 65-lb. line a reducing valve in a 400-lb. connection from the boiler header admits steam in sufficient quantities to hold the 65-lb. per sq.in.

This method is not only cheaper in first cost than the usual automatic bleeder pressure control, but is equally satisfactory, from a practical viewpoint, for cotton mills where load is quite constant during a large part of a day. Automatic oil-operated non-return valves are provided close to the turbine so that if the main throttle is tripped the non-return valves are also tripped to prevent reverse steam flow into the turbine from low-pressure lines.

Returning condensate flows through the condensers of the air ejectors, through the vapor condenser of the



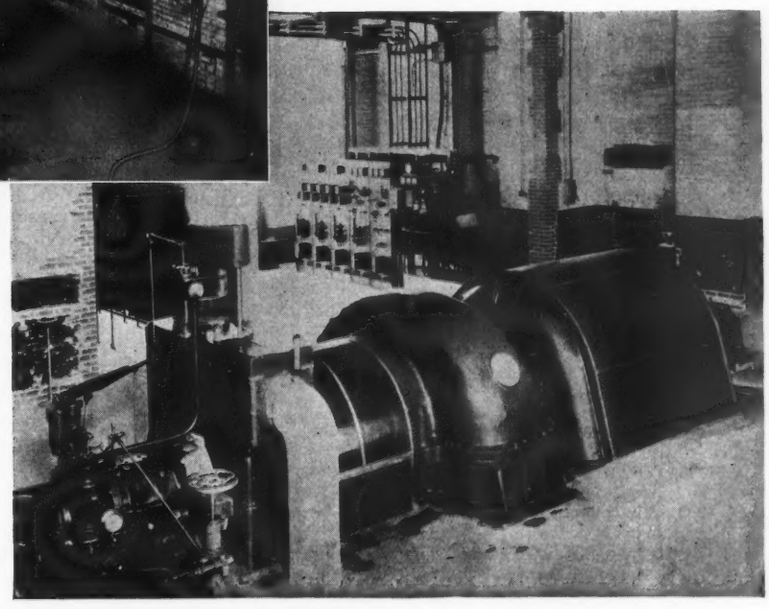


Fig. 2 (Above) — Auxiliary burners are shown below main burners. Fig. 3 (Right) —Normal load carried by 5,000-kw. turbine

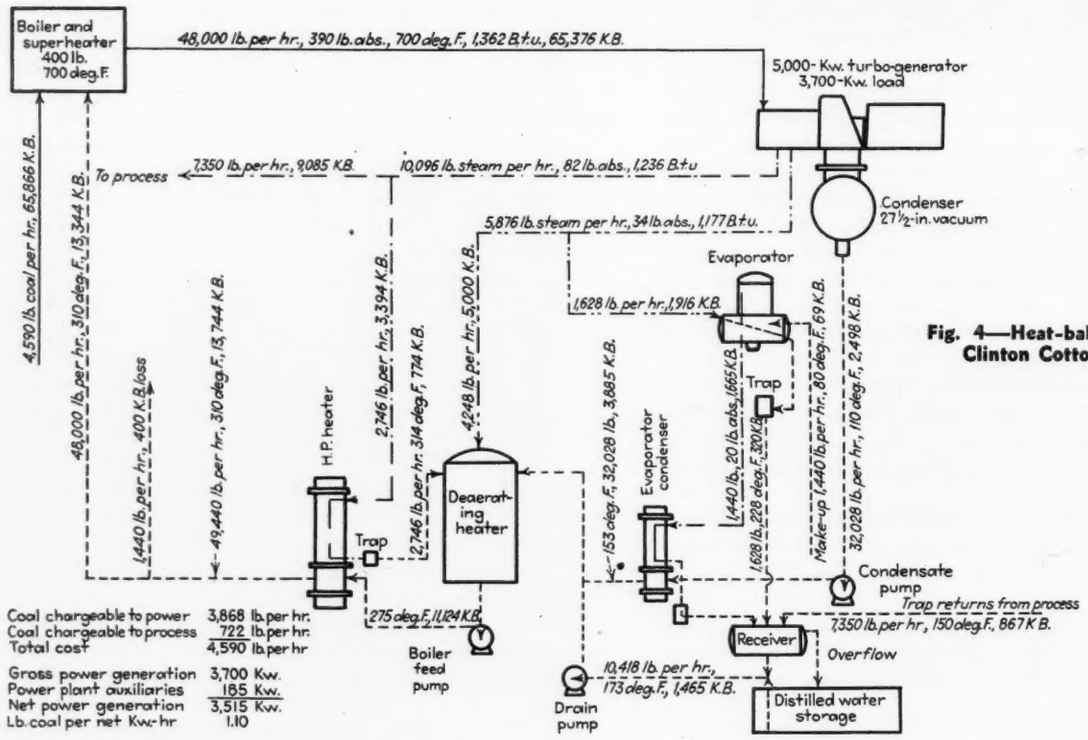

Boiler and superheater 400 lb. 700 deg.F.
48,000 lb. per hr., 390 lb. abs., 700 deg. F., 1,362 B.t.u., 65,376 K.B.
5,000-Kw. turbo-generator 3,700-Kw. load
To process
7,350 lb. per hr., 9,085 K.B.
10,096 lb. steam per hr., 82 lb. abs., 1,236 B.t.u.
Condenser 27½-in. vacuum
5,876 lb. steam per hr., 34 lb. abs., 1,177 B.t.u.
Evaporator
1,628 lb. per hr., 1,916 K.B.
4,590 lb. coal per hr., 65,866 K.B.
48,000 lb. per hr., 310 deg. F., 13,344 K.B.
1,440 lb. per hr., 400 K.B. loss
49,440 lb. per hr., 310 deg. F., 13,744 K.B.
2,746 lb. per hr., 3,394 K.B.
2,746 lb. per hr. 314 deg. F., 774 K.B.
42,248 lb. per hr., 5,000 K.B.
H.P. heater
Deaerating heater
Trap
Evaporator condenser
153 deg. F., 32,028 lb., 3,885 K.B.
1,440 lb., 20 lb. abs., 1,865 K.B.
1,628 lb., 228 deg. F., 300 K.B.
Trap
Make-up 1,440 lb. per hr., 80 deg. F., 69 K.B.
32,028 lb. per hr., 110 deg. F., 2,498 K.B.
Condensate pump
Trap returns from process
7,350 lb. per hr., 150 deg. F., 867 K.B.
Receiver
Overflow
275 deg. F., 11,124 K.B.
Boiler feed pump
10,418 lb. per hr., 173 deg. F., 1,465 K.B.
Drain pump
Distilled water storage
Coal chargeable to power 3,868 lb. per hr.
Coal chargeable to process 722 lb. per hr.
Total cost 4,590 lb. per hr
Gross power generation 3,700 Kw.
Power plant auxiliaries 185 Kw.
Net power generation 3,515 Kw.
Lb. coal per net Kw-hr 1.10

Fig. 4—Heat-balance diagram for Clinton Cotton Mills plant

evaporator and then into the 15-lb. deaerating heater. Plant high-pressure drips flash also into this heater direct.

Low-pressure drips process traps and evaporated makeup, discharge into a mixing surge tank and are pumped into the low-pressure heater. A float valve on this tank controls steam flow to the evaporator thus controlling quantity of makeup evaporated.

Power is generated at 2,400 volts 60 cycle, 3 phase. Generator surface air coolers use circulating water as the cooling medium. In addition to cooling, this closed system avoids the deposit of dirt and dust in the generator and limits fire hazard.

From the plant bus structure, power is transmitted to an outside transformer substation. Here, the voltage for the Clinton Mills, together with that for the plant auxiliaries is stepped down to 575 volts for local distribution. Other transformers in the same substation step up the voltage to 11,800 volts for transmission to the Lydia Mills. There it is also stepped down to 575 volts for local distribution.

Generation and distribution are both controlled from the plant switchboard in the turbine room. A swinging bracket on the side of the board carries a synchroscope and the other necessary instruments for paralleling the generators. The generator panels carry the necessary instruments and controls for both units. A voltage regulator with its switches for controlling both generators, is mounted on an adjacent panel.

Three panels handle distribution. One, of 200-kw. capacity, controls plant auxiliaries, the next, of 2,000 kw., controls distribution to the Lydia Mills, and the third, of 3,000 kw., handles current for the Clinton Mills. All three carry the necessary instruments and switchgear.

The plant was designed and constructed under supervision of George Hill, consulting engineer, Wellford, South Carolina.

ANOTHER QUESTION LIST

By THEO. J. DICK
Milwaukee, Wis.

Other lists appeared in April, May and August. Try these; then compare your answers with those on page 495.

1. What are the two meanings of the word "pressure" as used in engineering work?
2. (a). Why is water pressure directly proportional to the height of the water column?
   (b). What should be the height of a water column to exert a pressure of 1 lb. per sq. inch?
   (c). If a water wheel were supplied with water from a reservoir located 1,000 ft. above the wheel, what would be the pressure at the wheel?
3. What experiment proves that atmospheric pressure is capable of exerting quite a large force?
4. Why is the atmospheric pressure not directly proportional to the height of the air column?
5. What is the atmospheric pressure if the barometer reads 30 in.?
6. (a). What is a vacuum?
   (b). With an atmospheric pressure of 28.5 in., is a condenser vacuum of 29 in. possible?
7. What is meant by absolute pressure?
8. If the barometer reads 29.6 in. and the boiler gage reads 155 lb., what is the absolute boiler pressure?
9. The barometer reads 29.5 in. and the vacuum gage on the condenser reads 27.3 in. What is the absolute condenser pressure?
10. The engineer of a power plant 3,960 ft. above sea level maintains a vacuum in his condenser of 22.5 in. The engineer of another plant 2,640 ft. above sea level maintains a vacuum of 23.3 in. Which of the two condensers has the lower absolute pressure?

CHANGES IN OIL-TREATING SYSTEM KEEP COMPRESSOR BEARINGS COOL

By EZRA K. NICHOLSON
Cleveland, Ohio

CHANGES in the oil grooving of bearings on a number of large, heavy-duty compressors at the Du Pont Company's Belle Works were described in the February and April issues of *Power*. This article deals with the effect of types of oils and provisions for settling, filtering and cooling the recirculated bearing lubricant used on these machines.

Some unhappy experiences with a central oiling system serving several smaller compressors, wherein lubrication troubles on one machine spread to all the others, indicated the desirability of an individual bearing oiling system for each of the larger units.

This system, as originally installed, consisted of a settling tank with automatic water-removing siphon, a large capacity, four-bag filter and two double-end pumps operated through linkage by drag cranks on the crank-pin oiling banjos. This arrangement is shown in Fig. 1.

While changes in oil grooving largely eliminated bearing troubles during the winter months, bearings were still uncomfortably warm during the summer, when the room temperature was between 100 and 105 deg. F. The fact that these machines operated 24 hr. a day, seven days a week, allowed no idle intervals in which bearings and lubricant could cool and consequently increased the severity of the operating conditions.

The size and construction of the bearings made it quite difficult to keep them cool. The least expensive and perhaps the most effective method for accomplishing this appeared to be through supplying the bearings with a generous quantity of cool, clean lubricant.

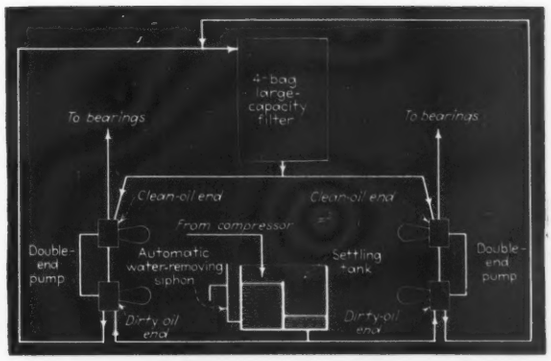
Two tubular-type coolers for cooling the oil were installed in series, the first cooled by water, the second by brine from the plant system. A third double-end pump was installed to insure the larger quantity of bearing lubricant required, and a second settling tank was also added to adequately handle the larger quantity of lubricant being circulated. The reconstructed arrangement is shown in Fig. 2.

Due to the construction and operation of these machines, water sometimes got into the bearing lubricating oil. A readily demulsible oil was therefore required, but at the same time, a reasonably heavy oil was necessary for the heavy bearing loads and the relatively high operating temperatures.

After a series of tests with oils of different viscosities, made by blending different proportions of bright stock and neutral oil, it was found that a readily demulsible oil was the most satisfactory for the operating conditions. This had a viscosity of 220 to 240 sec. Saybolt at 100 deg. F.

Another group of compressors had less severe bearing pressures, but their bearing lubricant was subject to water and sulphur contamination. This condition sometimes required frequent and expensive oil changes. We tried a light, readily demulsible and rather inexpensive spindle oil with a viscosity of 80 to 85 sec. Saybolt at 100 deg. F. Bearing loads on these machines were approximately 200 lb. per sq.in. for the main bearings and 850 lb. per sq.in for the crank bearings, as compared with loads of approximately 370 and 1,300 lb. per sq.in. on the main and crank bearings, respectively, of the first group of compressors. The light oil proved to be entirely satisfactory for the more lightly loaded bearings.

These two cases show the wide range of lubricating-oil viscosities that can be satisifactorily used for bearing lubrication on large reciprocating machines. Each particular case requires a careful analysis, confirmed if possible by operating tests, in order to obtain the most effective lubrication results with the minimum expenditure for equipment, operation and maintenance.



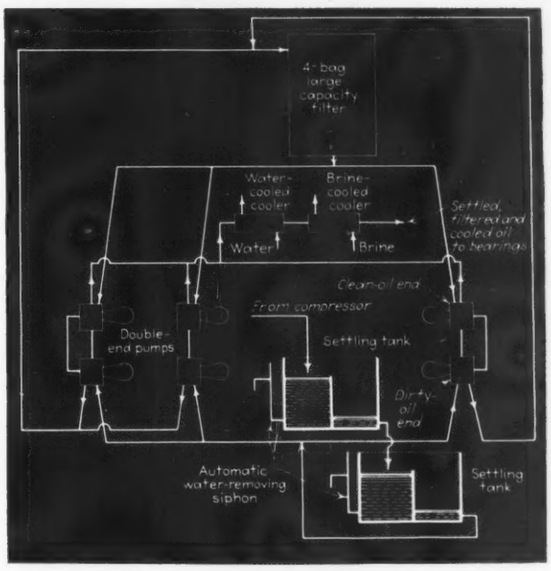
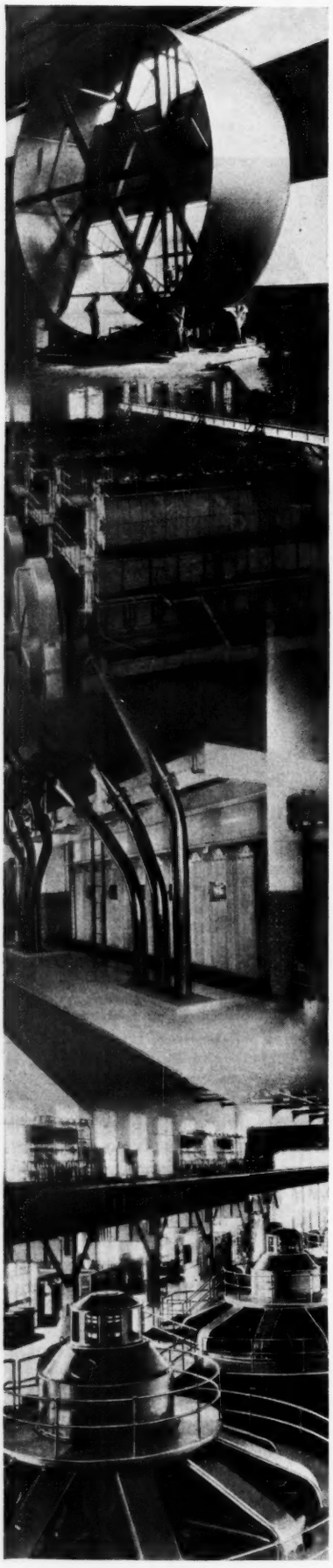


Fig. 1 (Top)—Oil-treating system as originally installed for large high-pressure gas compressors. Fig. 2—Reconstructed oil-treating system with extra pump, settling tank and oil coolers added



WHEN WILL CENTRAL

WHAT WILL

What executive engineers think

CENTRAL station output for the past several months has held close to the outputs of 1931 and within 5 per cent of the average load existing in 1929, when many systems experienced the largest outputs in their history. These loads are being experienced despite a general business index hovering in the neighborhood of 60-65 per cent. It is admitted that domestic loads have in general increased and in some measure account for the present high central station output. It seems, therefore, highly probable that any reasonable improvement in general business will result in central station loads exceeding the peaks of 1929 and 1930.

From 1931 to the present time, only 2,349,350 kw. of new central station generating capacity has been placed in service, and in 1934 no new capacity is expected. During these four years considerable generating equipment has become obsolete, removed from service and in some cases dismantled. The capacity definitely removed from future service, during this period, exceeds 747,000 kw. Thus the net capacity increase is only 1,602,350 kw. Previous to 1929, at least 2,000,000 kw. of new capacity was added yearly.

The year by year figures are:

	Capacity Added, kw.	Capacity Retired, kw.
1931	1,403,000	430,000
1932	600,000	106,000
1933	346,350	211,000
1934	0	
	2,349,350 kw.	747,000 kw.

Load connected to central station lines is greater than it has ever been, for millions of kilowatts have been added in the last three years. Connected load represents potential demand, and load that is now idle may cease to be idle rather suddenly. That central stations had adequate reserves for 1929 and 1930 does not mean that these reserves will be adequate for 1937.

While it is not thought that additional capacity will be required in 1935, it seems certain that many systems will need new generating equipment in 1936 and others by 1937. This new capacity will have to be sufficient to take care of increased manufacturing activity which may reasonably be expected by that time and a certain amount of normal growth which, up to 1929, had been at the rate of 10 per cent a year.

Past experience indicates that the time required from the first inquiry about new equipment to its first commercial operation varies from 13 to 24 months, depending upon the size of the units involved. Before any definite inquiries can be addressed to equipment manufacturers, studies and decisions will have to be made concerning the character of the capacity to be added. In fact, preliminary plans and designs should be well along. If capacity is to be added by 1936 or 1937, these studies and plans should be started now.

One of the effects of the depression has been the disorganization of engineering and design staffs—the natural result of efforts to decrease costs and the absence of new construction. These organizations are not easily re-established, and much time will elapse before new members of an engineering and design staff will be working efficiently. Consequently it should be expected that the time required for preliminary studies and plans will be much greater than when previous capacity was added.

Equipment manufacturers, too, have been forced to reduce their design and manufacturing personnel. As a result it must be expected that deliveries on new equipment built to order will be slower than normal. Likewise, if a number of utilities placed orders simultaneously for new capacity, the resulting "equipment traffic jam" would further delay deliveries. Certainly then, it is important that plans for new capacity be made well in advance of requirements. For many this means immediate action, otherwise decisions will be hurried and results inferior.

Plant design during the next few years will be greatly influenced by the cut-to-the-bone central station engin-

STATIONS ADD UNITS?

THEY BE?

By R. B. PURDY
Associate Editor

eering organizations. Faced with the necessity of acquiring new engineering talent, while at the same time proceeding with the design of plant additions, executive engineers will favor simple plants. They will be unwilling to attempt innovations. In general, 1935 engineering must start where 1930 left off just about as if the engineering were executed in 1931, because the engineer responsible for design will have to lean on experience, of which there is little since 1930.

In the design of new plants, greater attention will be given to dollar economy. It is believed executives will tolerate some loss of efficiency if by so doing capital expenditure is decreased. This attitude on the part of the executive will, to a certain extent, be forced because money for plant additions will not be as easy to obtain as it has been in the past.

Right at the start the engineer must choose between building new plants and enlarging old ones. This choice must of necessity hinge largely on existing local conditions. Some of these are rather obvious, such as availability of space for additional generating equipment in present plants, size of circulating water tunnels, quantity of condensing water, age and efficiency of plants, operating pressure, amount of capacity to be added, availability of satisfactory site for new station, desirability of new station located to meet distribution requirements and cost of new plant compared with cost of adding to present station.

Assuming local conditions favor the installations of new generating equipment in an existing station one must consider the many ways in which this can be accomplished. What is to be done will depend to a large extent upon whether the plant to be enlarged operates at 200-300 or 400 lb. pressure, whether it is relatively new or old, and whether the boiler plant is efficient.

If the plant is fairly new, operating at 400 lb. pressure or above, the new capacity should undoubtedly be similar to the existing equipment, operating at the same pressure and temperature and probably employing the same firing methods.

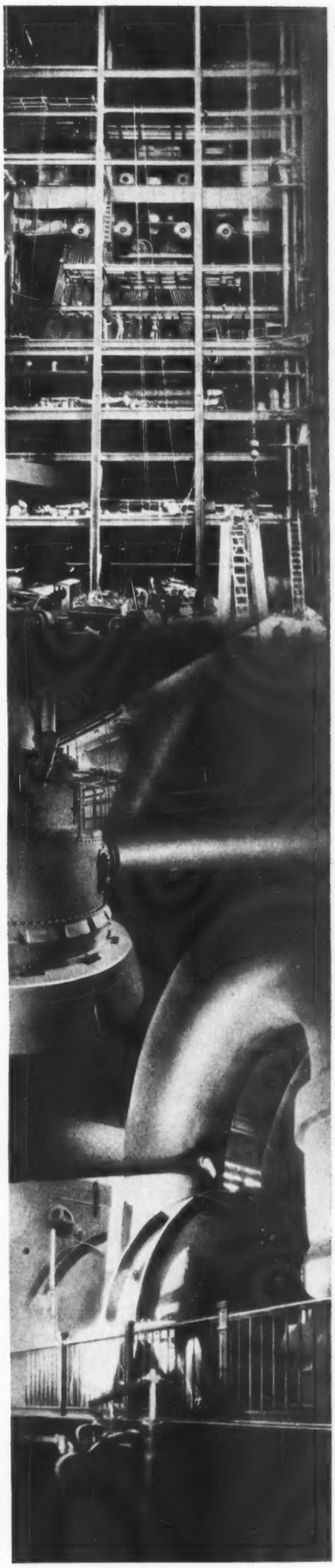
However, if the plant steam pressure is 200 to 350 lb. the possibility of adding a "top" should be given considerable study. This may take the form of a 1,200- to 1,400-lb. unit with reheating or a 700-lb., 850-deg. unit without reheat both exhausting to existing turbines or the mercury vapor cycle.

Experience with the mercury-vapor "top" is so limited that few, if any, such installations are anticipated within the next few years. Nevertheless, this cycle holds much promise and should be watched and studied.

Another possibility is the modernization of existing equipment to operate at present plant pressure and temperature. It is often possible to replace an old turbine-generator with a new, more efficient unit of greater capacity in practically the same space occupied by the old unit. While this both improves station economy and adds capacity, the amount of capacity added is likely to be small. Additional steaming capacity required for the larger unit can often be obtained by changes in boilers and firing equipment to permit higher ratings. If however, new boilers are required, it will probably be more economical to change to higher pressures and temperatures.

In some systems it will be possible to add capacity by adding a generating unit to an incompleted hydroplant. Generally the new unit will be similar to those already installed and, hence require less engineering. Sometimes, however, it has been found desirable to make changes in the new unit as dictated by experience with the turbines already operating in the plant. Such changes may be in speed or setting with respect to tailwater level, etc.

Further discussion of methods of increasing central station capacity by adding "tops" and new plants will appear in the October number.



By ROBERT DRAKE
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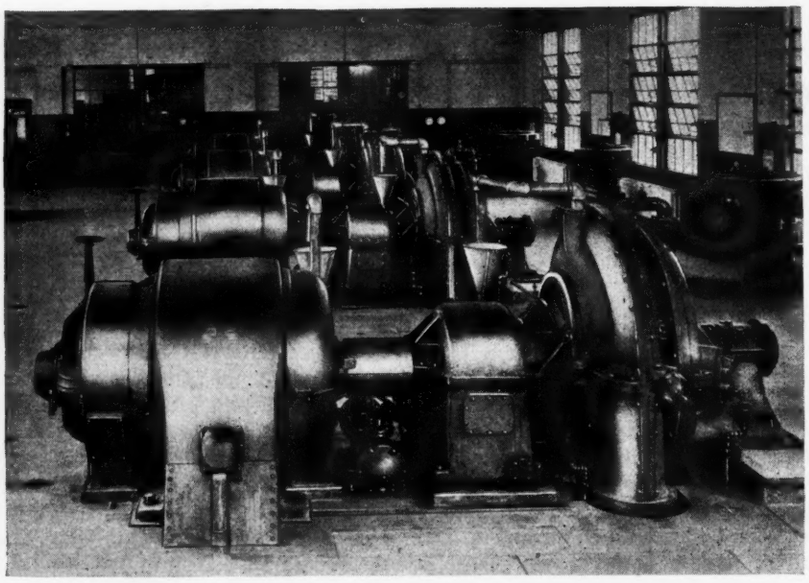
Consideration is given to direct-connection; open flat belts with pivoted-base motors; flat belts with idler pulleys; multiple V-belts; chains; gear units and the protection of the motor and driven machine



Rotary gas compressors driven through increasing gears by induction motors

CONNECTING MOTOR AND LOAD

WHEN the speed of a machine is high enough, directly connecting the driving motor to it by a solid or flexible coupling is the simplest and frequently the best drive. A high-grade flexible coupling is almost always preferable to a solid coupling, because an emergency motor change when necessary can be made with less delay than when a solid coupling is used. Before adopting a direct-connected drive it is well to consider its disadvantages.

With a constant-speed motor directly connected to a machine without wide-range speed control built in, subsequent change in speed is difficult. Even when so great a change in speed is desirable, the substitution of another motor of the next higher standard speed is expensive. Replacing a motor with one of the next lower speed is even more difficult and expensive, because the slower-speed motor has larger dimensions. Occasions for speed changes in the machine are not infrequent. With flat-belt, V-belt, silent-chain, or roller-chain drives, a moderate change in speed may be quickly and easily accomplished simply by a change of pulleys, sheaves, or sprockets.

In fan installations it is customary to allow in the design for a considerable decrease in delivery with time, due to duct incrustation, and also to provide for uncertainties in estimating duct resistance. Frequently allowance is necessary to care for probable increase in air demand from additional outlets that may be installed. With a direct-connected fan this means, according to usual practice, that the fan is initially run faster than is necessary. A special small-diameter runner could be installed at first and replaced from time to time with a larger one ending in 5 to 15 years with a standard runner, but this is seldom done.

Power required by a fan decreases 30 per cent for a 10 per cent decrease in speed and 50 per cent for a 20 per cent decrease in speed, while the corresponding decrease in volume delivered is only 10 per cent and 20 per cent respectively. Because of this relation a handsome saving may usually be made during the first few years of an adequately planned fan installation by operation at reduced speed. The choice between belts of various types or chain drives depends upon conditions in a particular job.

One of the principal disadvantages associated with small machines individually driven has been a large number of manufacturing delays from motor breakdowns. With individual drive there are from 8 to 20 times as many motors as would be required to drive the same machines in groups. For individual drive the motors are much smaller, wound with smaller wire in partly closed slots instead of open slots. Each motor is generally subject to far greater extremes of load than with group drive and is more likely to be roasted out.

This last difficulty may be met more or less successfully in several ways. For many years electrical manufacturers have endeavored to develop relays which would allow a motor to carry heavy momentary overloads and shut it down if an overload persisted until a dangerous winding temperature was reached. Early designs of these relays left much to be desired, either because they allowed operators to abuse a motor, because dashpots stuck from corrosion or other causes, or because the relay characteristics were such as to make oversize motors necessary to take care of widely fluctuating loads. Within the last two or three years, motor-protective devices have been developed that give close to ideal performance. In one, the simple actuating device is in contact with the motor.

A shearing pin is the only device I know of that will save a machine with a heavy flywheel when something jams. When such a machine is stalled, a properly proportioned shearing pin in the coupling between the flywheel and machine prevents breaking the machine

frame. Opening the motor circuit will not prevent the flywheel from wrecking the frame. Sometimes weak bearing cap bolts or similar expedients are used. They are less reliable than the shearing pin due to uncertainty of the initial tension in the bolts.

A pivoted motor-base drive offers another method of guarding against infrequent abnormal load peaks. By altering the driving motor's position on its base one of these drives can be adjusted to carry any desired overload and no more. Once adjusted, the overload which the drive will carry is not affected by belt stretch or other influences. When the load swings even momentarily above that for which the drive is adjusted, the belt slips.

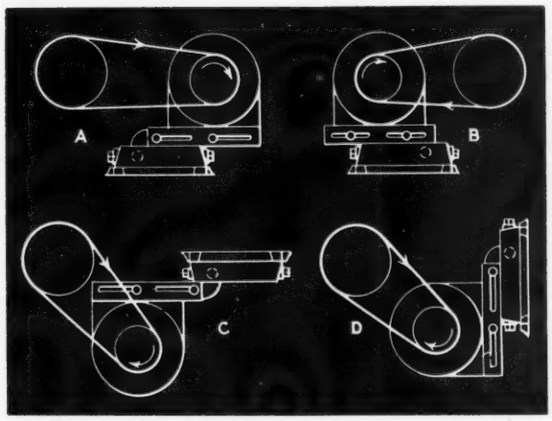


Fig. 1—Mounting for pivoted-base motor drives

When the manufacturer knows the requirements of a job, these drives are adjusted to carry 50 per cent overload or a little more. They can, however, be adjusted on the job to carry any load within rather wide limits.

Motor bearing failures and the consequent destruction of the winding by the rotor striking the stator, and the entrance of foreign matter into the motor cause a large part of the failures of motors driving individual machines. Both faults may be to a large degree eliminated by expedients readily available.

Motor manufacturers supply their equipment with ball or roller bearings at very small additional cost over sleeve-bearing motors. Ball or roller bearings wear very slowly, and in motors so equipped the rotor seldom strikes the stator. In fact I do not know of one case where this has happened in my somewhat extensive experience. This does not indicate that anti-friction bearings last forever, or that they do not wear loose. It simply means that they wear very slowly and give unmistakable evidence of distress long before the rotor strikes the stator.

When anti-friction bearing motors are first used in a plant, several bearing failures are likely to be experienced because neither ball nor roller bearings will stand the thrust shock of having pulleys, sprockets or pinions driven on against them with a sledge, even though the shaft end is heavily "dollied up." Soon after each such occurrence one or both of the bearings may fail. Once the maintenance crew learns to press or drive on pinions or pulleys without putting thrust on the bearings, bearing failures practically cease.

Such failures as do occur result from excessive overloading of bearings. Where ball bearings on motors are overloaded, substitution of a roller for a ball bearing on the pulley end will increase the permissible bearing loading by about 100 per cent. Although roller bearings are made in styles identical and interchangeable as to external dimensions with ball bearings, this substitution frequently cannot be made in high-speed motors of fairly large sizes, such as 40-hp. 1,800-r.p.m. and 75- hp. 1,200-r.p.m. The speed limit of roller bearings is lower than that of ball bearings, size for size.

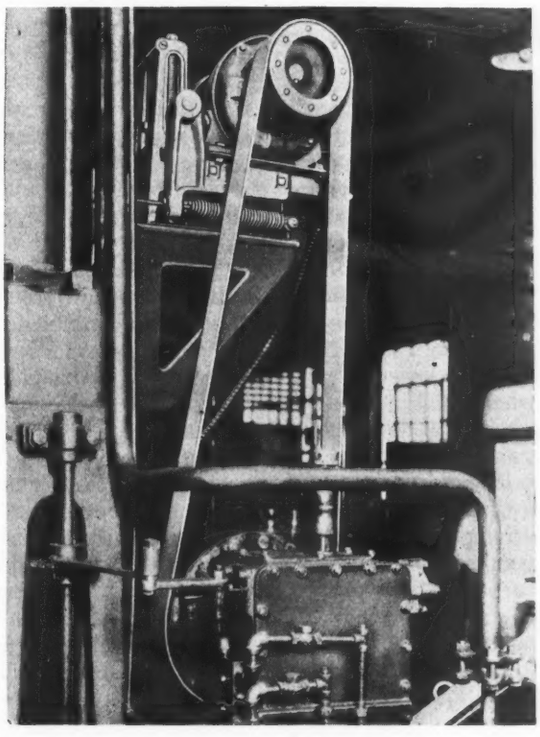
When we approach the border line of satisfactory practice, we reach a region where the difference between satisfactory service and failure of a flat or V-belt drive depends upon judgment of the man who adjusts belt tension from time to time as the belt elongates. If the belt is overtightened either inadvertently or to allow for subsequent stretch, the bearings will overheat or fail. If adjustments are made a little oftener and better judgment used as to tension, the drive may run for many years.

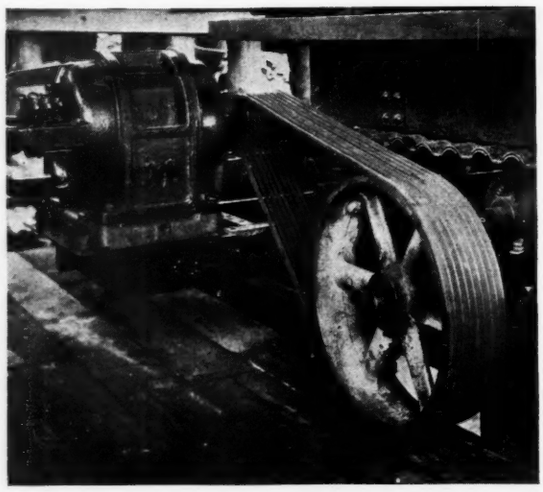
On such short-center drives a pivoted motor-base installation with the tight strand of the belt on the favorable side, or a gravity idler with an idle pulley of ample diameter set not too close to the adjacent drive pulley, once correctly adjusted, will assure a trouble-free, long-lived drive.

Should a pivoted-base drive layout work in such manner as to throw the tight strand of the belt on the less favorable side, that is, on the pulley side opposite to the hinge pin as in Fig. 1*A*, then it is best to alter the drive according to one of the arrangements, *B*, *C* or *D*. Drives with the tight strand on the less favorable side will operate satisfactorily when conditions are favorable and extreme peak loads are not encountered, but they are to be avoided in border-line cases.

Whether motors are floor mounted or bracketed high upon the machine frame, belt drives to individually driven machines are likely to operate on very short

Fig. 2—Vertical mounting of pivoted-base motor driving high-pressure oil pump





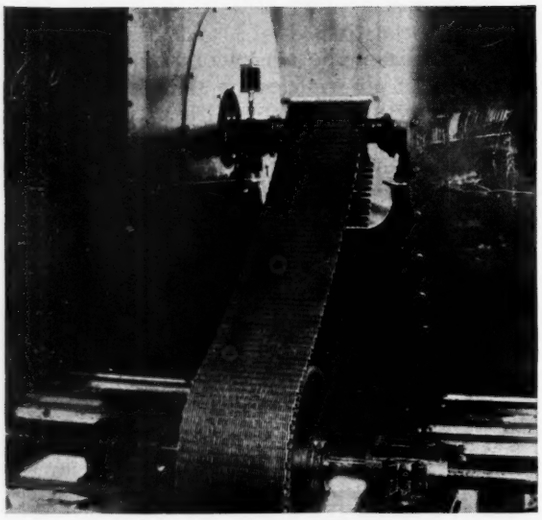


Fig. 3 (Top)—Multiple V-belt connects wound-rotor motor to apron feeder. Fig. 4—Large fan driven by 100-hp. silent chain

centers and may require a vertical or nearly vertical drive. The ordinary open-belt drive will under such conditions have a high slip unless given frequent and intelligent maintenance, and in many cases with unfavorable pulley ratio will slip objectionably anyway.

A pivoted motor base or a gravity idler, will, if properly designed, eliminate slip and reduce creep below 1½ per cent for the idler drive and below ¾ per cent with a pivoted-base drive. The advantage noted in the past in horizontal drives as compared with vertical ones is in the superior performance of the horizontal drive when the belt stretches and develops slack. When a mechanical device is used to secure uniform belt tension automatically this advantage no longer exists.

The usual design of pivoted motor base cannot be used with a vertical drive having a motor above the driving pulley. One manufacturer of such drives offers a modified type of pivoted-base drive designed for this particular type of application, Fig. 2. In applying idlers to short-center drives the diameter of the idler pulley should be ample, and the idler should not be too close to either pulley.

Multiple V-belts may be applied to short-center drives and give better performance than flat belts without automatic means for maintaining belt tensions and taking up slack. This is particularly true of vertical drives. V-belt, like pivoted motor base drives, cannot be used on vertical drives when the distance between pulleys cannot be changed to take care of belt stretch. The field in which the V-belts may be satisfactorily applied is somewhat narrower than that of flat belts, but within these limits it is an excellent drive.

When applying V-belts to driving machines with heavy load fluctuations and high speeds, it is advisable to use belt capacity considerably in excess of the manufacturers recommendations. We must not lose sight of the fact that belts must carry peak loads without slipping, as well as the average loads. Good performance is much more necessary at peak loads than at light loads.

Chain drives have a somewhat narrower field of application than flat or V-belts, but there are certain classes of service where they are superior. For the best results chains should be run enclosed. With proper inclosures they may be operated successfully under conditions of dust, oil, water and steam, so severe that belts would give trouble. Similarly with suitable special lubricants chains may be run under heat conditions which would quickly destroy any belt of whatever material. These qualities, combined with the absence of slip and creep, gives a chain drive a field where it has no competition, except perhaps inclosed-gear drives.

For long life, chains should be continuously lubricated, which is easier to accomplish in an inclosed mounting. Splash or flinger-disk lubrication is most usual. At high speeds the lubricant must be applied on the inside of the strand for if applied to the outside centrifugal force will throw it off before it reaches the pins at all. Vertical silent-chain drives can be operated if means are provided for taking up the slight slack resulting from pin wear but are best avoided unless they can be assured intelligent routine inspection. For long trouble-free service, silent chains should not be operated above 1,300 or at most 1,500 ft. per minute.

Years ago, the only way to obtain long trouble-free service on open gears, with the possible exception of drives of quite small capacity, was to use slow-speed motors with their more rugged bearings. The introduction of rawhide pinions improved matters considerably, reduced shock on gear teeth, vibration and noise. Hydraulically compressed cloth as a pinion material retains the advantages of rawhide pinions, with some improvement in strength for the same width, and increased life. If dressed every one to three months with a paste of shellac and flake graphite, such pinions will last for years even in such service as coal, sand and ash-handling machinery.

There has been wonderful improvement in inclosed gear speed reducers both as to reduced power losses, and durability. Their life has been increased several fold by the use of heat-treated alloy steel gears, and improved bearings of the anti-friction and sleeve types. Several new and highly efficient types of reducers have become available, such as one-, two- and three-stage helical and herringbone reducers. Many modern types of reducers have efficiencies in the 90's and when ratios are favorable in the high 90's. Thus in many instances replacement of an old style reducer will pay for itself in power saved and reduced expenditure for replacement parts in two years or less, and keep right on making comparable savings.

STANDARDIZED DIESEL-ELECTRIC SETS

By WM. W. GAYLORD
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THE suggestion made by R. M. Schaefer in the May number of *Power* (page 232) of installing 64 diesel sets in a single plant shows the possibilities of these in the larger plants, but there are probably even greater possibilities in the relatively small plant. The larger plant can buy power, in most cases, at much more favorable rates, and if care is used to keep the peak loads within reason, can often buy it for less than the cost of generating with diesel-driven generators if all fixed charges are included.

There are, however, many smaller plants that have requirements of from 100 to 500 kw. which are either buying power under unfavorable conditions or making it with obsolete steam-driven equipment at a high cost. Most of these have motors and wiring systems for 3-phase, 60-cycle current at 220 or 440 volts and the standardized set should, of course, be designed to run at a speed that will supply this. The set would probably be designed to run at 1,800 r.p.m. and be equipped with a 75-kw. generator.

The question of spare equipment and maintenance would, of course, be more serious in a small plant. A spare unit in a plant requiring a 200-kw. capacity would increase investment nearly one-third. Routine maintenance could be taken care of by the plant mechanic, but any major overhaul would call for outside assistance in most cases. Of course we can visualize a condition in which the makers of these standardized units will maintain service stations where spare units will be held in stock, and a service provided by which one of these can be put in the place of a unit needing overhaul, and this unit taken to the service station and reconditioned by experts at a reasonable cost. Until and unless such service is available, it will be necessary for each plant to provide its own spare equipment if it desires insurance of continuous service.

An example will show what might be expected of such a plant:

Assume a plant with an average load of 180 kw. and a peak of 220 kw. that operates 2,000 hr. per year with four such units installed. Fuel oil will cost about 6 cents per gallon and such a set should deliver about 12 kw.-hr. per gal. The cost of these sets complete with auxiliaries and switchboard should not be over $80.00 per kw. installed, (probably considerably less when made on a production basis) and the fixed charges (interest, depreciation, insurance and taxes) not over 15 per cent.

The annual use of power in this case would then be $180 \times 2{,}000 = 360{,}000$ kw.-hr. or 30,000 kw.-hr. per month. The operating cost will be about as follows on a kw.-hr. basis:

Fuel @ 6c per gal. and 10 kw.-hr. per gal.	0.6
Lubricating oil, cents per kw.-hr.	0.12
Supplies and Maintenance, cents per kw.-hr.	0.16
Attendance (not constant), cents per kw.-hr.	0.17
Total per kw.-hr., cents	1.05

Then total annual operating cost will be 360,000 kw.-hr. at $0.0105 = $3,780.

The corresponding cost of purchased power under a simple rate but one which is fairly representative of the average Southern New England city will be:

A demand charge of $3 per month per kw. of maximum demand and an energy charge of 3 cents per kw.-hr. with a discount for a 220 kw. demand of 50 per cent to apply to both demand and energy charges which make the annual cost

220-kw. demand @ $3 x 12 =	$ 7,920.00
360,000 kw.-hr. @ $0.03 =	10,800.00
Total	18,720.00
Less 50% discount	9,360.00
Total annual net cost	9,360.00

This shows a saving in operating cost by generation of $9,360 — $3,780 = $5,580 which is a return of 23.25% on the $24,000 investment required, or 8.25% in addition to that allowed for fixed charges.

If the plant had operated 4,000 hr., two shifts, the saving would have been $7,200 or 30% return on the investment.

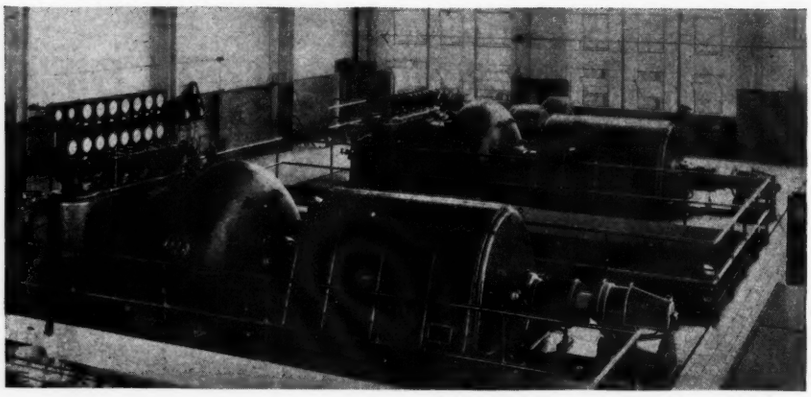
Stated in another way, the generating plant when operated 2,000 hr. a year will pay for itself in six years, or when operated 4,000 hr. in less than four and a half years.

While the figures given apply only to the case assumed, they do show the possibilities of this type of equipment in any such plant where the cost of power is 2 cents per kw.-hr. or over. This high-speed standardized unit is apparently not yet commercially available, but slower-speed units are available which compare very favorably in operating characteristics, and these are built in a range of sizes to meet almost any requirements. The first cost in these small sizes is, however, materially higher, usually running from $120 to $150 per kw., and this makes fixed charges so much higher that a higher load factor is needed to show a proper return on the investment.

In many industrial plants, spare equipment is not considered essential, as the diesel of today is a very reliable machine. In the example given above, if no spare equipment is to be provided the most satisfactory units commercially available would probably be two of 120-kw. capacity, which could be installed at a cost of about $125 per kw. The plant would then pay for itself in about eight years with 2,000 hr. operation or less than six years with 4,000 hr. operation.

In one city where the power rates have always been relatively high, at least half the plants now buying power are raising the question of the savings to be made by diesels. In most of these cases a preliminary estimate indicates that sufficient savings can be made to pay for the generating equipment including a spare unit.

By J. D. CARSON



PARALLEL OPERATION OF EXTRACTION TURBINES

INDUSTRIAL electrical load is usually reasonably constant during any one shift of operation, exclusive of starting and stopping periods. Steam load, however, is not so constant, varying considerably as various processes come on and off the line. Heating load varies markedly from early morning to mid-afternoon, and process load will be unusually heavy after a shut-down, as for a week-end, when process baths and machinery have become cold.

To take care of this varying steam load, manufacturers equip their turbines with devices to control the amount of steam by-passed to the extraction line from the usual line of flow to the condenser. Ring-type grid valves are usually employed.

Position of this grid-valve is controlled by a mechanism sensitive to extraction-line pressure. Of these mechanisms there are two types, pressure-controlled and interlocked. Those that move only the grid valve to compensate for changes in extraction load, leaving the speed governor to move the main admission valve, are called pressure controlled. In the interlocked type, grid and main admission valves are moved together, relative movements of the two valves being controlled by a mechanical linkage moved jointly by the pressure control and the speed governor. With the first type, electrical output changes every time the grid valve is moved, but with the second type, electrical output is maintained substantially constant throughout the whole range of extraction loads.

In parallel operation, the problem is to set machines so that one or more of them will extract steam at the most economical rate, and one will take steam load variations. This can best be done by assigning constant-load duty to machines with pressure control and regulating duty to a machine having interlocked control. In this way electrical output of the machines will not be so greatly affected by changes in process-steam demand. The regulating machine should have its governor set very sensitively at the proper pressure. Constant-load machines should have their governors set sluggishly, so that a considerable variation in both steam and electrical load will be needed to change the position of either grid valve or main admission valve.

Pressure controls on the constant load machines should not be set for the full extraction pressure, but for such a pressure as will give the best rate of extraction. This usually will be about 70 to 85 per cent of full-pressure setting. On some machines it is possible to rig up a thumbscrew arrangement that will enable the operator to set the grid-valve at the desired opening and have it stay there regardless of load changes, which is convenient for base-load operation.

Extraction turbines should be brought up to speed, synchronized, and closed in on the line with the grid valve wide open, operating straight condensing. After at least half the electrical load is picked up, the grid valve should be closed until the pressure in the extraction stage is equal to that of the process header. During this picking up of steam load, a pressure-controlled machine will drop 10 to 20 per cent of its electrical load and an interlocked control machine will pick up 20 to 40 per cent more load.

After the machines have been properly adjusted, leave the controls alone. More operating errors come from too much juggling of controls than from not enough. If extraction pressure drops, close the grid valve on a base-load machine, and if pressure goes too high, open the grid valve. It is best to do this changing on only one machine, to keep the others extracting at their best rate.

Probably the most important single part in an extraction turbine layout is the non-return or balanced check-valve between process header and extraction chamber of the turbine. This valve must be kept in perfect condition for safety's sake.

In taking an extraction-type machine off the line, the grid valve is moved to wide-open position, stopping the flow of extraction steam and allowing the check-valve to close. The machine, now operating straight condensing, is worked off the electrical load with the speed governor and tripped off the line. If the check valve does not close when the grid valve is opened, steam from the process header will feed back into the extraction chamber and pass through the last stages of the

turbine to the condenser, causing the machine to overspeed. Even though the overspeed governor trips the main throttle valve the machine will continue to gain speed because it is running on low-pressure steam fed into the last stages, beyond the control of throttle valve or speed governor. The only way to stop the machine is to shut off the low-pressure steam feeding it by manually closing the check valve, or a stop valve in the extraction line. For this reason it is a good idea to install pull chains on the check-valve balance-weight lever so that it can be forced shut in an emergency. Several modern check valves have an oil cylinder connected with the overspeed trip to force the check valve shut.

I am acquainted with two machines that had expensive shutdowns from extraction steam overspeeding. One is a 1,500-kw. unit operated on 150-lb. pressure with extraction at 15 lb. Reducing valves, set to start operating when pressure drops to 14 lb., are used to supply low-pressure steam when the turbine is shut down. The machine was tripped off the line by an electrical disturbance, and the check valve jammed open. The speed governor closed the admission valve and the pressure control closed the grid valve. Extraction pressure dropped at once, and the reducing valves started to operate. Steam from the reducing valves backed up in the extraction line, raising pressure and causing the grid valve to open, giving steam from the reducing valve free passage through the last turbine stages. The machine ran away until the check was manually closed. All the armature banding wire in a direct-connected exciter was broken, coils loosened in the slots, and rotor unbalanced.

The other machine, a 2,000-kw. unit, supplied with steam at 210 lb. pressure, with extraction at 15 lb. was operated in parallel with other turbines on steam and electrical output. It was damaged by an operating error. The operator worked electrical load off the machine with the speed governor and tripped it out without opening the grid valve and working off the extraction steam load. The check valve jammed open, and the machine ran away until the valve was manually closed. Damage was a wrecked exciter, several buckets thrown out of the last-stage wheel and a stretched wheel.

Occasionally an extraction-type turbine must be run as a synchronous condenser. This is best done by starting up the machine, synchronizing, and closing in on the line in the usual manner. Then, with the grid valve blocked wide open and full excitation on the generator, admission valves are closed by the speed governor until the generator no longer delivers power to the line. Enough steam will then be passing through the machine to maintain vacuum. Unless a machine is specifically designed for such service, it should never be run as a synchronous condenser without at least 20 in. of vacuum. This means, of course, that circulating water, hot well, and vacuum pumps must be operated as though the machine were carrying a full load. It is necessary to carry vacuum so that wheels in the last stages, which normally run under vacuum, will not be heated to a dangerous temperature by air friction.

Starting and Stopping Extraction Turbines

1. Don't start the machine with the grid valve closed.
2. Don't try to extract steam unless the condenser is working and vacuum is right.
3. Pick up about half of the electrical load before extracting steam.
4. Watch the extraction flow-meters and load up each machine with the amount of steam it carries best.

When Shutting Down

1. Ease off steam load, lock the grid valve open, and *be sure* the check valve closes.
2. Work off electrical load and come off the line.

THEO. J. DICK gives this

LIST OF ANSWERS

to his questions on page 486.

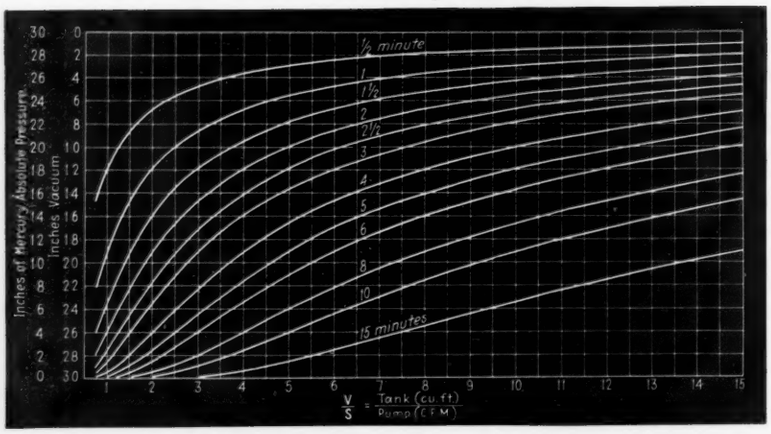
1. Pressure may denote the total force exerted by a body, or it may refer to the force exerted upon a unit of area.
2. (a). Because water is practically incompressible.

   (b). $1 : 0.433 :: X : 1;\ X = \frac{1}{0.433} = 2.31$ ft.

   (c). $0.433 \times 1{,}000 = 433$ lb. per sq. in.
3. Magdeburg hemispheres. The atmospheric pressure holds the two halves together.
4. Surrounding the earth is an ocean of air many miles deep. This air has weight and exerts a pressure on all objects with which it comes in contact. The pressure per square inch at any level is equal to the weight of a 1-sq. in. column of air running from that point up to the limit of the atmosphere. In an air column the air at the bottom is compressed by that above. Therefore, air weighs less per cubic foot at higher elevations. As a result the pressure of air does not vary directly with the height of the air column.
5. One cubic inch of mercury weighs 0.49 lb. To find the atmospheric pressure, multiply the barometer reading in inches by 0.49. Thus $30 \times 0.49 = 14.7$ lb. per sq. in.
6. (a). A vacuum is a space where the pressure is less than atmospheric. A perfect vacuum has never been attained.

   (b). No.
7. Pressures measured from a perfect vacuum are called absolute pressures. The barometer gives us the pressure of the atmosphere above a perfect vacuum, and the ordinary pressure gage gives us the pressure above the atmosphere. The absolute pressure equals the atmospheric pressure plus the gage pressure.
8. $29.6 \times 0.49 = 14.5$ lb. (atmospheric pressure).
   $155 + 14.5 = 169.5$ lb. (absolute pressure).
9. 29.5 in. $- 27.3$ in. $= 2.2$ in.
   $2.2 \times 0.49 = 1.08$ lb. sq. in. abs.
10. Since the vacuum gage reads in inches of mercury, this reading times 0.49 will give us the corresponding pressure below the atmosphere.
    $22.5 \times .49 = 11.025$ lb. per sq. in.
    $23.3 \times .49 = 11.417$ lb. per sq. in.
    From a table showing the atmospheric pressures for dry air corresponding to various altitudes we get the following: at 2,640 ft. (½ mile) elevation the atmospheric pressure = 13.33 lb. per sq. in. At 3,960 ft. (¾ mile) elevation the atmospheric pressure = 12.66 lb. per sq. in. To get the absolute pressure in a space where there is a partial vacuum, subtract the pressure indicated on the vacuum gage from the atmospheric pressure.
    $12.66 - 11.025 = 1.635$ lb. (abs.) in the cond. at 3,960 ft. elev.
    $13.33 - 11.417 = 1.913$ lb. (abs.) in the cond. at 2,640 ft. elev.
    The condenser at the 3,960 ft. elevation has a lower absolute pressure by $1.913 - 1{,}635 = 0.278$ lb. per sq. in.

HOW LONG TO EMPTY AN AIR TANK



By DAVID FLIEGELMAN
Coppus Engineering Corp.

WE HAVE had occasion to solve several problems that had to do with the removal of air from a tank by means of a vacuum pump. With the scant information available, we found that solution of these problems involved laborious and complicated computations. To simplify these solutions, we made the set of curves shown on the chart.

Problems to be solved usually fall in three groups:

Group 1—Size of air tank and air pump given, to find how long it will take for the air in the tank to drop to a certain pressure or vacuum.

Group 2—Size of air tank given, to find what size of vacuum pump is required to reduce the pressure to a desired value in a given time.

Group 3—Size of air tank and air pump given, to find the air pressure in the tank at the end of a certain number of minutes.

A problem in any of these three groups can be solved easily and quickly by use of the chart. The vertical co-ordinates give the pressure in the air tank in inches of mercury (absolute pressure) and the corresponding vacuum in inches of mercury. The maximum pressure shown is 30 in. pressure (or 0 in. vacuum) corresponding to atmospheric pressure. It is assumed that atmospheric pressure exists in the air tank at the start. Horizontal co-ordinates give the ratio of V to S where V is the volume of the air tank in cubic feet and S is the size of the vacuum pump in cubic feet per minute.

Example 1—With a 40-cu.ft. air tank and a 20-c.f.m. vacuum pump, how long will it take for the pressure to drop from atmospheric pressure (30 in. mercury) to 14 in mercury? $\frac{V}{S}=\frac{40}{20}=2$ and reference to the chart shows the time required will be 1½ min.

Example 2—With a 60-cu.ft. air tank, what size vacuum pump is required to reduce the air pressure in the tank from atmospheric pressure to 20 in. mercury in 3 min.? The chart shows that $\frac{V}{S}$ (ratio of tank to pump capacity) should be 7.5. Since V is 60 cu.ft., the vacuum pump should be $\frac{60}{7.5}=8$ c.f.m.

Example 3—Given the volume of air tank as 75 cu.ft. and the size of the vacuum pump as 15 c.f.m., what will be the pressure in the air tank after 10 min.? $\frac{V}{S}=\frac{75}{15}=5$ and the chart gives 4 in. mercury pressure or 26 in. vacuum as the pressure resulting after 10 min.

The curves on the chart were plotted from the formula

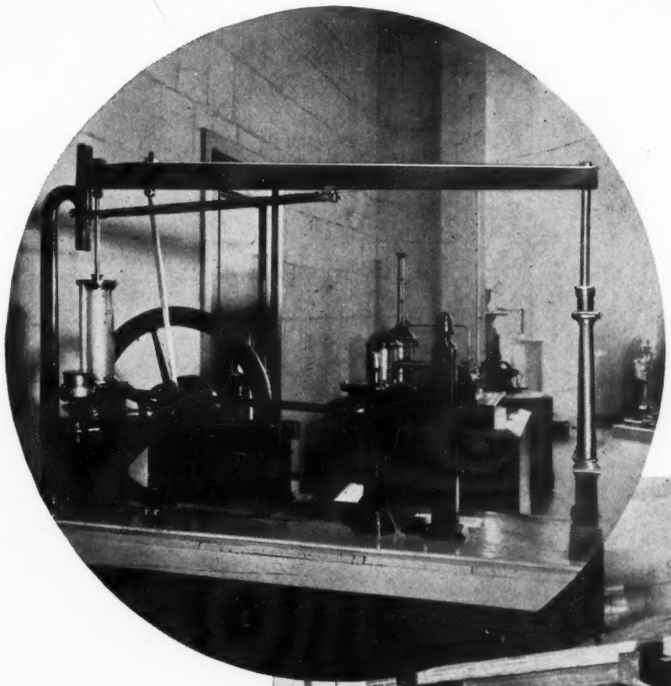
$$X=V\left[\left(\frac{P_i}{P_f}\right)^{\frac{1}{n}}-1\right]$$

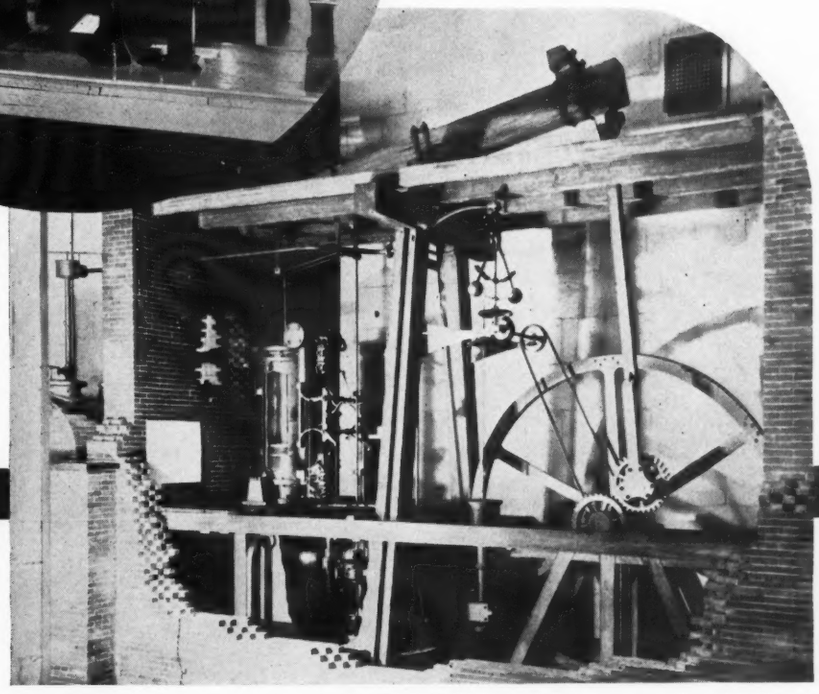
where X = cu.ft. displacement of air pump per second, V = volume of air tank in cu.ft., P_i = initial pressure (absolute) in tank, P_f = final pressure (absolute) in tank after n seconds, and n = time in seconds.

Although the curves on the chart give the time in minutes, n in the formula was used as time in seconds. This gave a number of points for plotting our curves, on the assumption that the pressure in the tank remained constant for only one second. Had we used n as time in minutes the points obtained would be on the assumption that the pressure in the tank remained constant for a whole minute. Investigation showed that using seconds as the increment of time gave points for plotting curves which were wholly satisfactory for practical problems.

The new Mersey vehicular tunnel, England, is nearly 2½ times the largest American tunnel. Six ventilation plants, housing 30 fans, supply fresh air and remove vitiated air. The largest of these fans will deliver 641,000 c.f.m. and have impeller diameters of 28 ft. Casings of these large fans are constructed of reinforced concrete 9 in. thick. They vary in diameter to a maximum of 50 ft. and in width from 10 to 16 ft. Total capacity of the six plants is 2½ million cu.ft. of fresh air per min. and an equal volume of exhaust air.

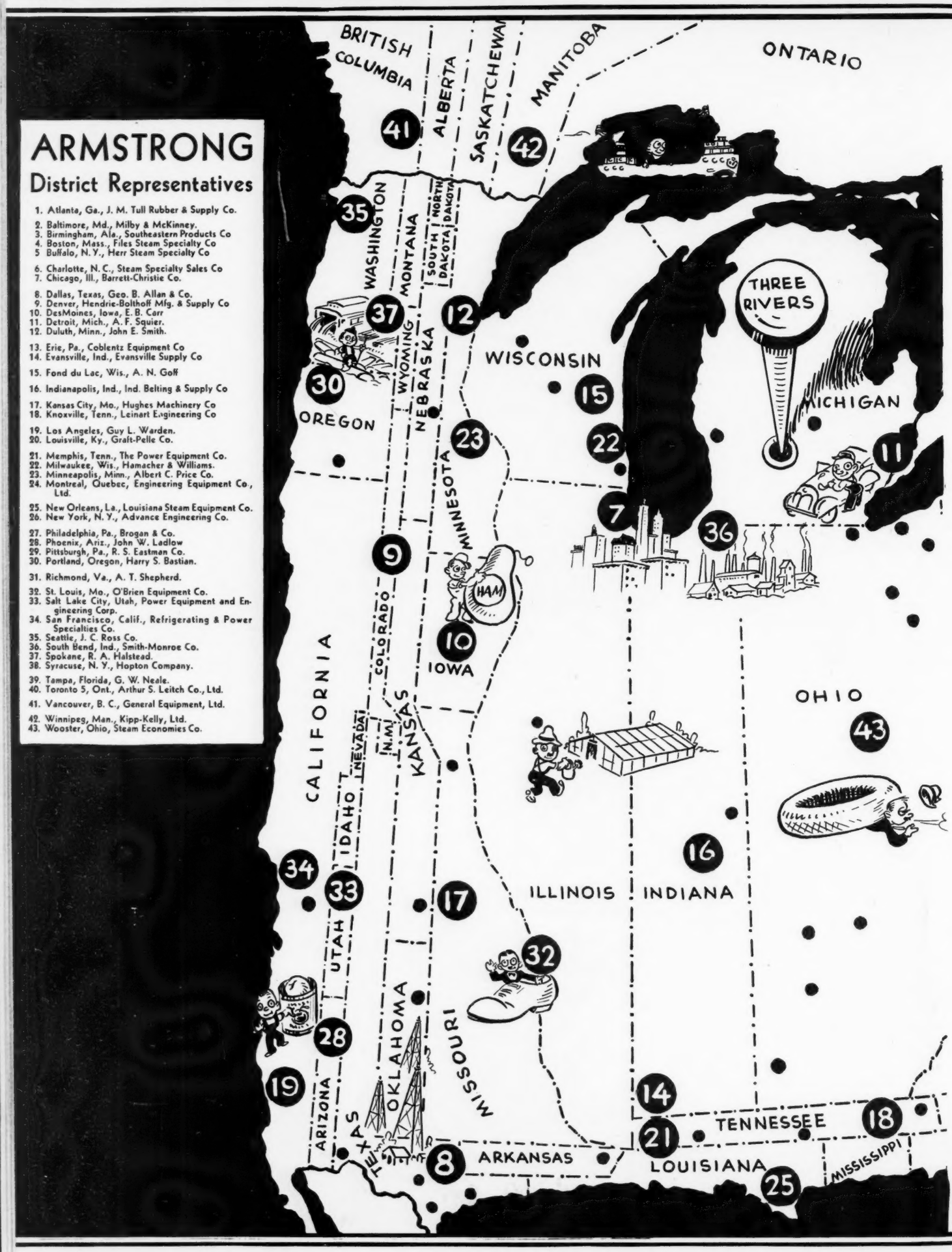
FAMOUS OLD ENGINES





THESE three models of famous old engines grace the new museum building of Franklin Institute, Philadelphia, visited by 350,000 people since its opening Jan. 1. At top is a quarter-size model of Newcomen's atmospheric pumping engine of 1711. At center is a model of Oliver Evan's "high-pressure" 20x60-in. engine set up at Fairmount Water Works in 1817. Rotary steam valves were driven by bevel gears, and the engine pumped 36,621 gal. of water in a 23½-hr. test with 194-200-lb. steam. At bottom is a half-size model of Watt's Sun and Planet Engine of 1785. This arrangement is one of several Watt developed to circumvent the absurd patent granted to Pickard on the crank and connecting rod

THE DISTRIBUTION OF BOILER



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District Representatives

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2. Baltimore, Md., Milby & McKinney.
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9. Denver, Hendrie-Bolthoff Mfg. & Supply Co
10. DesMoines, Iowa, E. B. Carr
11. Detroit, Mich., A. F. Squier.
12. Duluth, Minn., John E. Smith.
13. Erie, Pa., Coblentz Equipment Co
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18. Knoxville, Tenn., Leinart Engineering Co
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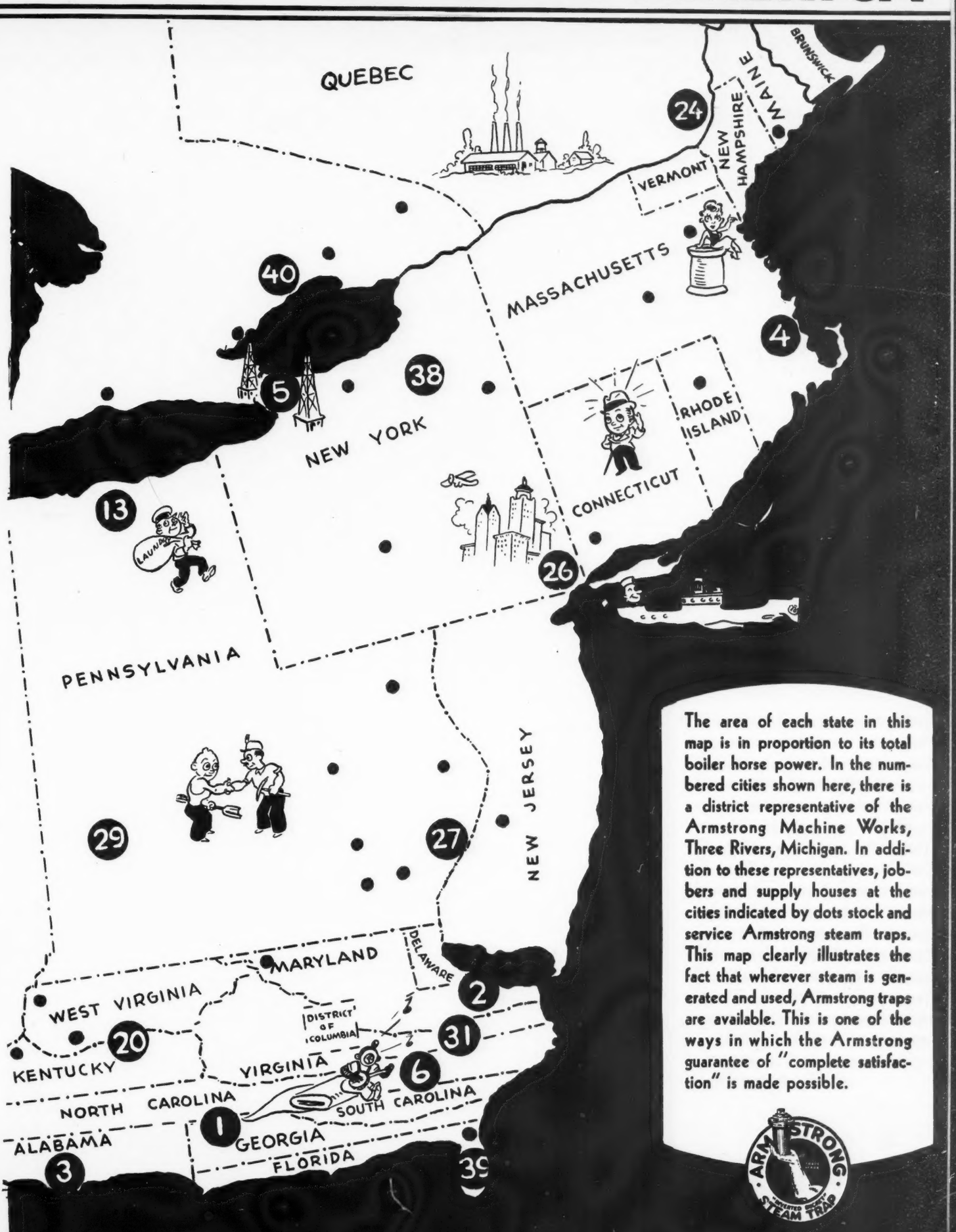
PARALLELS THE DISTRIBUTION

HORSE POWER IN AMERICA



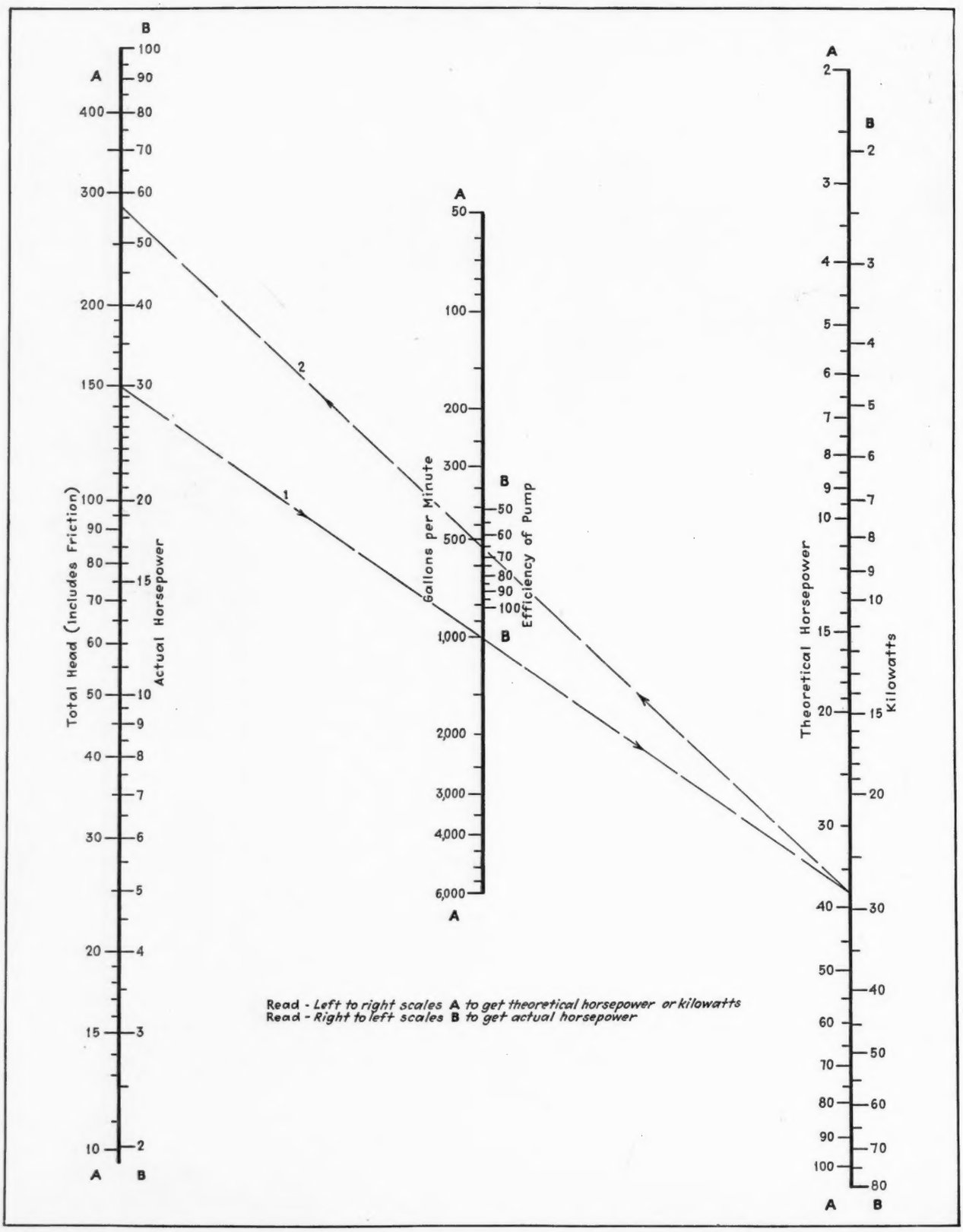
The area of each state in this map is in proportion to its total boiler horse power. In the numbered cities shown here, there is a district representative of the Armstrong Machine Works, Three Rivers, Michigan. In addition to these representatives, jobbers and supply houses at the cities indicated by dots stock and service Armstrong steam traps. This map clearly illustrates the fact that wherever steam is generated and used, Armstrong traps are available. This is one of the ways in which the Armstrong guarantee of "complete satisfaction" is made possible.

ARMSTRONG
INVERTED BUCKET
STEAM TRAP

OF ARMSTRONG STEAM TRAPS

Number 24

POWER REQUIRED FOR PUMPING WATER

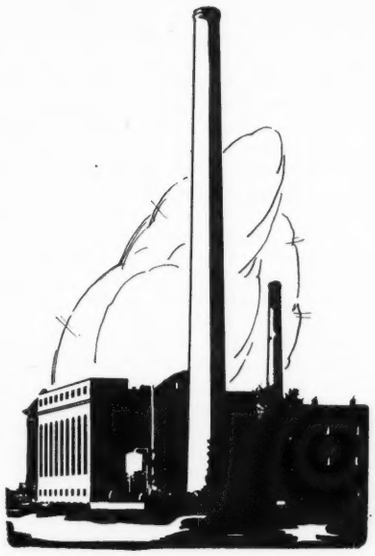

Total Head (Includes Friction)
Actual Horsepower
Gallons per Minute
Efficiency of Pump
Theoretical Horsepower
Kilowatts
1
2
Read - Left to right scales A to get theoretical horsepower or kilowatts
Read - Right to left scales B to get actual horsepower

By W. C. Hirn, *Consulting Engineer*

© POWER

FIFTY YEARS

The past, present and future of power generation, as seen by operators and engineers



The June number marked Power's *fiftieth anniversary. Further to commemorate a half-century of progress, the editor invited a number of engineers to send him their thoughts on the past, present or future of power generation. Four pages of these letters were published in the July number, others, equally interesting, in August.*

1884—1934—Future

• 1884-1934; what a period to cover by one publication! This is without doubt the most important period in the history of power development. By 1884, Edison's first central station for the New York Edison Co. had been operating about a year. His plant consisted of Jumbo dynamos driven by reciprocating steam engines. The predominating boilers in this country were of the locomotive and return tubular types. The water-tube boiler had been built in small sizes, but was used only to a limited extent. All equipment was small and steam pressures in stationary boilers seldom exceeded 150 lb. Combustion was a simple affair. Grate bars supported a bed of burning coal or wood, hand fired.

The operating engineer was generally a graduate fireman clad in overalls and interested principally in keeping his plant in running order. His discussion concerned valve setting, lubrication problems and the cussedness of firemen. Millwright work constituted a large part of his duties in the maintenance of belts and line-shafts.

The power plant of 1934 contains, in general, steam turbines, the first of which (a 6 electric horsepower machine) was built in 1884. Many single units in use today equal, if not exceed, the total capacity of all prime movers of 1884. The reciprocating steam engine, universally used in 1884, has been relegated to rather simple services and is seldom employed in large plants. An even more astounding change has taken place in electrical equipment.

The boiler room has become recognized as the heart of the modern plant, where every device that science can offer is employed to improve the efficiency of steam generation from fuel. Mechanical stokers, pulverized coal, oil fuel and natural gas, with mechanical handling of fuel and ash, have largely eliminated the manual work of the boiler operator. Modern boiler rooms are clean and well lighted. In place of a black-faced, grimy fireman of 1884, today's operator may put in his day without soiling his starched collar. His work is that of a highly trained director whose will is executed by mechanical or electrical devices rather than by human labor.

Many other things have happened in these fifty years. Engineering has become recognized as a profession that demands the best trained minds of the country and many of the younger generation have joined its ranks. Schools of engineering have become important factors in our educational life.

We would be remiss if we failed to express the great debt that those interested in the power industry owe to that sterling friend and guide, Fred R. Low, who was for so many years editor of *Power* and its guiding spirit. He never failed to encourage men to develop new ideas. Through his urge, firemen and engineers took to study as a means of bettering themselves in their callings. Wise counsellor, stalwart friend and able editor, Fred R. Low will always remain a leader of this era of power development.

Let us look ahead before closing. Shall we build larger power plants and still greater turbines? This seems self-evident. But what about the use of diesel-engine plants at the ends of transmission lines, or for peak-load service, or even as prime movers where fuel oil is cheap?

In boilers, shall we return to the gas producer and then burn our fuel as gas in boilers under pressure as in the Velox boilers abroad? What will be the economic limits of pressure and temperature? Steam pressures of 3,200 lb. and temperatures of 1,000 deg. F. are already possible, but by no means the ultimate limits.

Power development is still in a pioneer stage in spite of this fifty years of improvement. The capacities of our central stations must be increased several times to take care of the demand when our domestic consumers catch up to those of Manitoba in the use of electricity. In the meantime, we talk of the "all-electric" house with still greater requirements. Power developments to meet our needs in the next fifty years will demand as great advances as in the past. There are still great opportunities for many engineers of the best ability in this ever-expanding field of power generation.

A. G. CHRISTIE,
Professor of Mechanical Engineering
Johns Hopkins University

Subscriber Since 1884

• I have been a subscriber to *Power* since its first issue, and wish to state that I prize it more than anything else in its line and derive great benefit from it.

When I first received it, I was sure there was not much that I did not know, but as time went on I recognized the fact that I could still learn. I now have arrived at the point where I recognize that I know but little and rely on *Power* to help me out, which it does as it is full of information that would be hard to attain otherwise.

G. D. STEVENS,
Fort Wayne Corrugated Paper Co.

All Boilers Welded

• IF THERE are any boiler makers so wedded to old boiler practice as to think there can be nothing better, they should retire forthwith, for the radical changes of the recent past will be more than matched by others now developing.

The introduction and widespread use of steam turbines is the factor most responsible for the very great changes which have taken place in the design, construction and operation of steam boilers during the past fifteen or twenty years. The evaporative capacities of boilers have exceeded anything imagined ten years ago. While it is not likely that any larger units will be proposed, designs are constantly being changed in the interest of simplicity of operation, construction and increased economy.

Possibly those interested in the shop work are the ones most affected as regards the effect on modern boiler demands on shop practice. Riveting can no longer be considered "plenty good." Welded construction throughout is inevitable and while this is confined at the moment principally to the fabrication of drums and shells, there is no doubt that fusion welding will eventually be used throughout in the construction of boilers of all types. This means the obsolescence of heavy and expensive machinery adapted to the riveting processes, and the installation of new equipment adapted to welding methods,

both as regards the actual work and the means for determining the soundness of the work after completion.

These remarks about boiler construction apply with equal force to the construction of pressure vessels of all kinds. Any one concerned with the operation of a plate-fabricating shop is blind to the necessities of the situation if he is not informing himself in great detail about all the requirements for doing welding work as it should be done. It is now generally recognized that the determination of the proper procedure and the materials to be used is a function of the mangement and not something that can be left to the judgment of the man who actually manipulates the welding equipment.

One must keep constantly in touch with the progress of the art of fusion welding because it is making rapid strides in development of both methods and materials as well as in the supervision and training of the men who do the work.

My principal regret is that I cannot continue to live indefinitely in order to see the inevitable improvements that are to come and which will be as interesting, if not more so, as those which I have seen in forty years of close contact with the boiler and pressure-vessel industry.

E. R. FISH,
Chief Engineer, Boiler Division, Hartford Steam Boiler Insurance & Inspection Co.

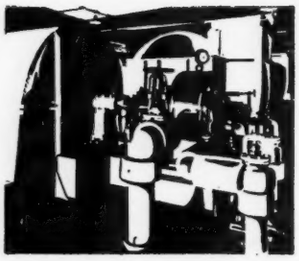
2500 Volts on the Hay Chopper

• IN 1888 we up here in Vermont had heard of electric lights, but few of the natives had ever seen one. I remember going to Rutland (about 50 miles) to see an electric light—an arc lamp hung from a mast arm on the old Bates House. Alternating current was being talked about, but there was none in this state at that time. Built in 1890, the station of which I was superintendent installed three 50-light, 2,500-volt, d.c. arc generators. We had water power most of the time to run them, but had steam engines for emergency use.

When I look back and see what we had to work with in those days, and how little we knew, I can't help but think how true is the saying "Where ignorance is bliss, 'tis folly to be wise." To illustrate: A friend of mine was a great lover of horses. He had a hand-operated hay chopper and came to me to get him an electric motor to run it. I told him we had no d.c. and knew of no motors that would run on alternating current. He said, "What is the matter with the arc current, that is d.c. and will start a motor all right." I said I never heard of such a motor running on 10 amps. and 2,500 volts, but that guy wouldn't take my word for it.

A few weeks later he saw me and said he had found a 3-hp. motor that would run on my arc current. I went to his barn to look over the motor. The nameplate read "3-hp. d.c. motor; amps. 10; volts, 50 to 2,500; r.p.m., 3,500. I installed it in the hay barn, with No. 6 W.P. wire from the street line to the motor, with a bare-knife switch which you could open and send the street light current to the motor.

Lord save us, how that motor did run when that switch was opened! Talk about 3,500; I bet it went 10,000. It would chop enough hay in ten minutes to last a week, and how pretty that blue flame on the



commutator was. He used this motor a long time, although for only a few minutes at a time. The current was in the barn all the time the street circuit was on. There was no trouble, no one was hurt, no fire started, nor was anything unusual thought of it. "Verily the Lord doth guard His chosen."

I can look back and see hundreds of foolish things I used to do, all through ignorance and not intent, but I have not the time to tell more, nor would you want to give the space for more. I have been in the power game 60 years. About 46 years ago I commenced taking *Power*. I have read every number since, and must be one of your oldest subscribers. I have received much help from *Power* and congratulate you on your Fiftieth Anniversary. When you celebrate the centennial I shall try and write you a good article on my experience in the power field between now and then. So long—till 1984.

FRANKLIN BARNEY,
Springfield, Vt.

How About Engineers?

• ABOUT TWO YEARS ago the National Association of Power Engineers celebrated its fiftieth anniversary with a great jubilee. Truly, fifty years is a long time. The fiftieth anniversary of *Power* is it's reward for service to the engineering field. Every issue reveals new strides in engineering. *Power's* editorials always encourage economy and efficiency in the use of our natural resources.

The average engineer comes in direct contact with but few of the many types of power-plant apparatus. His desire for further knowledge in his field prompts him to associate with other engineers and to study engineering periodicals.

The engineers of this country have done a wonderful job. Praise is no return, however, for their untiring efforts. Let us show them our sincere appreciation by putting them back to work. Give them renewed incentive to lessen man's burden by allowing them to share the gains.

Isolated plants should be encouraged wherever possible. In bygone days these plants were profitable to owners and gave employment to many. Owners seem to forget that while central stations have increased their efficiency, the builders of isolated power plant equipment have also moved ahead and can erect plants far more efficient and compact than those of thirty years ago.

I hope that *Power* will live a long and useful life in the greatest field of all, service to mankind.

GEORGE GRIFFEL,
Chief Engineer, Hotel Victoria, N. Y.

The "Dynamo Tender"

• THINK OF those "good old days" when power stations were used only for lighting, starting at sunset and stopping when the sun rose again:

Switchboards or "hen roosts" are crude affairs—two upright pieces of hardwood to which are nailed slats of the same material. To this framework is attached what few instruments are in use at the time; voltmeter, ammeter and so-called "ground detector." Switches are mounted directly on the face of the board and leave much to be desired. Fuses on the outgoing circuits are mounted at the top of the board. No circuit breakers are available for a.c. use.

Station operation is surely no place for a nervous man. The arrival of a thunder shower is not hailed with delight. One is standing right beside a machine and the lightning goes through it, jumping from the commutator to shaft, then to ground. The belt screeches as the armature is short circuited. One hears the noise of the discharge and smells burning insulation.

"Safety first" was one thing not given any thought in those days, and it is remarkable that there were no more accidents.

LEON L. POLLARD.
Brunswick, Me.

Operation in 1890

• CONGRATULATIONS, *Power,* on this your fiftieth anniversary. I have been a constant reader for forty-two years, having been a subscriber since June, 1892. Before that time I bought the paper then known as *Steam* at the news stands, anxiously awaiting its arrival each month. Since then until the last year I have been continuously engaged in the installation, operation and maintenance of power houses and equipment both here and abroad, and thus observed at first hand the many changes and developments of the industry.

The Edison three-wire system was orthodox when in the early nineties the country broke out with open-arc lamps for street lighting, usually on the "moonlight schedule." The conversion of horse cars to trolley with motor drive had occurred in Richmond, Va., Dayton and Cincinnati, Ohio, and a few other cities. From the standpoint of today all were crude and primitive. There were no oil-ring bearings, no carbon brushes, no oil switches. No wattmeters, except the Edison electrolytic meter.

Troubles began to develop thick and fast. Among the first was the difficulty of getting "dynamos" to operate in parallel. Frequently they were driven one by a slow-speed Corliss engine and the other by a "high-speed" (200-r.p.m.) engine with a shaft governor. Everything else was hand regulation. The "dynamo tender" had plenty to do besides keeping awake.

Frequently there were no indicators in the plant, except the steam gauge and a "pilot lamp" hung over each machine to indicate the voltage. The load was estimated by the "feel" of the temperature, the sparking of the brushes and the sag or tension of the driving belts. Hot bearings, slipping belts, shorted lines, leaking boilers, etc., were all in a day's work.

The circuits were "protected" by fuses. When they blew out, larger ones were sub-

stituted. If they failed to blow, the next procedure was to "burn off" the ground, that is, open all switches and then with your back turned toward the switch, close the one on the shorted line. Next came the fire department. The practice had at least the merit of being effective, unless the driving belts were thrown off the machines.

When Tesla's three-phase system was developed by the Westinghouse Mfg. Co., the industry really got under way. Meantime isolated direct-current plants were being installed not only in the larger buildings for lighting but were being extended to serve shops, mines, etc., for both lighting and motor drive. They all seem crude and simple now, but to the early pioneers the difficulties were real. For example, the old smooth-drum armatures wound by hand furnished their share of trouble.

Power has contributed much to the cause during the past half-century. I hope it will continue its usefulness for another fifty years or more.

A. F. Elliott,
Chelsea, Ala.

David vs. Goliath

• IN STEAM-ELECTRIC power production, power passes from shaft of prime mover to shaft of electric generator. In the early days the inherently slow-speed engine drove the preferably and economically high speed generator by a belt; sometimes by two belts. In an early railway power house in Pittsburgh a 500-hp. engine drove a number of 100-kw. generators (the largest available) through a jack shaft. As larger generators were designed their speeds were inherently lower; heavy belts were bad and the generators were reduced in speed and increased in cost to secure direct driving. Direct-driven railway generators of say 75 r.p.m. and 500 to 800 kw. of thirty years ago represented the consummation of a century of engine development and a quarter of a century of generator development.

Then the generator outgrew the engine. The alternating current generators for the Elevated and Subway in New York — some 30 years ago — had an enormous vertical engine cylinder at each end of their shafts, and also an enormous horizontal cylinder at each end. Formerly it was a 500-hp. engine and several generators. Now it was a 5,000-kw. generator and several engines.

Apparently a stopping point had been reached. The Westinghouse Electric had built a high bay to handle a machine 43 ft. high; it had devised a surveyor's transit method of laying out its castings for machining; it was ready for orders for the largest units which steam engines could reasonably drive. But the orders didn't come. In fact many of the original outfits which were in splendid operating condition after 20 years were scrapped.

George Westinghouse, working on a rotary engine since boyhood, about 1890 adopted the Parsons turbine and undertook its development. Just as the big generators were beginning to run the Elevated trains in New York the first turbine from the same factory—1,500 kw.—was starting at Hartford, Conn. The engine was doomed. The era of the turbine had come. New technique, new designs, new materials were essential for turbine and for generator.

The assumption that progress had reached its limit in size was a natural one. But complacency had a jolt and progress is demonstrated when a new method overcomes the old limits set by reciprocating pistons. A single rotating spindle now produces many times the power that was supplied by the four cylinders on each of the 8 outfits in the early 40,000-kw. 79th Street power house.

As I think back over my own ideas and attitudes toward power, an outstanding experience was this disruption of the idea that the 5,000-kw., 75-r.p.m. alternator was to be the standard of the future. The early turbine experiments seemed so small in comparison with the gigantic engine equipment that there was a sort of David-and-Goliath assumption that the giant was all-powerful.

After Hartford soon came the new Chicago station with its 5,000-kw. vertical turbines. The new era in power had come.

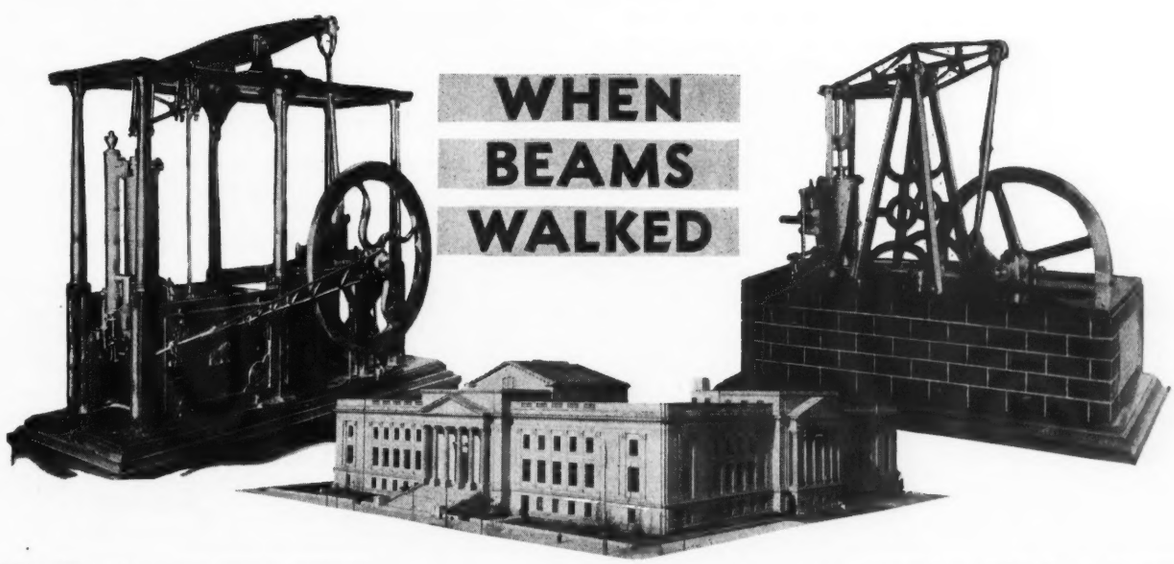
Chas. F. Scott,
New Haven, Conn.

Men—Journals—Societies

• THE POWER-PLANT JOURNAL brought to the minds of engineers many things they would not have known otherwise. Your veteran editor, Fred Low, had the faculty of stating facts pertaining to the uses of steam in such manner that they were easily understandable to the old-time engineers. Prior to Mr. Low what had been written was not clear and was not read to any great extent by the practical men. He is given credit by many engineers who are now passing on as being the one that started them on the way to learn something of the forces under their control.

Engineering societies, too, have played a real part in this development of today. They have brought engineers together and permitted the mutual exchange of ideas. They have helped the younger men to a better understanding of engineering topics. In this state I firmly believe that the work of placing a license law on the statute books was a great help.

T. N. Kelsey,
Lowell, Mass.



• THE walking beam was once as essential in a steam engine as the piston. At left is a model of a Watt walking beam engine used for mine pumping as early as 1803. At right is a model of an American design by Henry Cartwright of Philadelphia, modeled after Watt's design about 1820-1830 and used in Fairmount Water Works. These models both are housed in the new museum building (center) of "The Benjamin Franklin Memorial and The Franklin Institute," Philadelphia's 100-year-old scientific society, where are also shown the models pictured on page 497 of this number.

WORLD'S LARGEST CABLEWAY

TO SERVE BOULDER-DAM PLANT

By C. C. CLYMER
Industrial Engineering Dept.
General Electric Company

To lower heavy material from the canyon top to Boulder Dam power house, a 150-ton cableway is required, more than four times the capacity of any cableway previously built

CABLEWAYS are usually associated with the construction of large dams. On the Boulder Dam project, however, a cableway, the largest one so far built, is used for the construction of the power house and penstocks. The power house, because of its unusual location, and because of the great weight and size of the machinery to be installed, requires unusual construction practices. Black-Canyon highway, which serves the project, is 592 ft. above the power-house landing platform.

To gain the power-house floor on either side of the river by means of a connecting railroad would require traversing an unusually rugged and inaccessible country. Assuming a grade averaging 3½ per cent, construction of approximately 3.8 mi. of very difficult railway would be required, in addition to a bridge over the Colorado River. When the expense of such an undertaking is considered, it is evident that the construction of a cableway as now built is only incidental. The cableway has the additional advantage of being able to handle bulkier loads than would be possible with a railroad. Much of the material is so large that rail shipment is not possible, and it is therefore being fabricated at the site. The penstock liners include 4,700 ft. of pipe 30 ft. in diameter, some sections of which will weigh approximately 185 tons, the principal sections weighing 150 tons. There is also about 1,900 ft. of pipe 13 ft. in diameter, and 2,300 ft. of pipe 8.5 ft. in diameter.

The fifteen main generators, rated 82,500 kva. at 150 r.p.m. because of the condition under which they must operate, are equivalent to 125,000-kva. machines under normal conditions. They are the largest generators so far constructed. Each machine weighs 2,000,000 lb. and the heaviest single piece, the shaft and bottom hub flange, 125,000 lb. The transformers stepping the voltage up to 287,500 are the largest so far constructed, the weight of one transformer without oil being 155 tons.

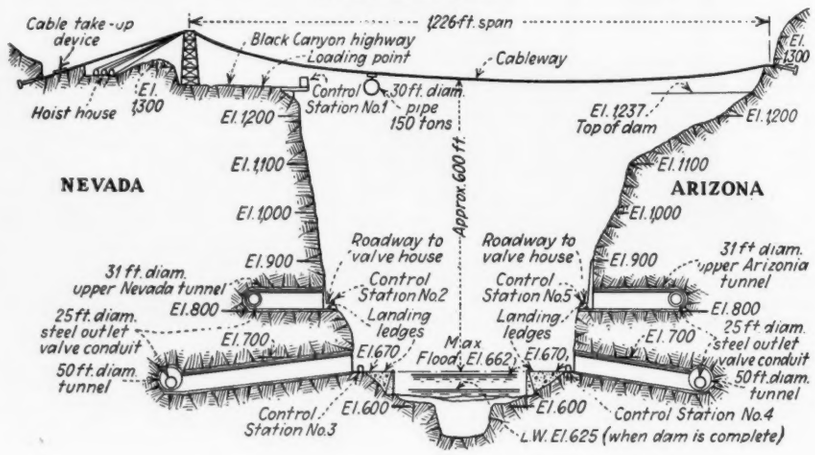
Handling of this material over such a terrain is a formidable problem. To solve it, the Department of the Interior investigated all possible methods, the final decision being the cableway as most satisfactory, all factors considered.

This cableway, which has a capacity of 150 tons, is a permanent structure designed for the life of the project. Its capacity exceeds by more than four times that of any other heretofore constructed. Six main-track cables 3.5 in. in diameter are used to support the load. These cables are of 6x37 lang-lay construction with a wire-rope center. The distance between track saddles is approximately 1,226 ft. Anchorages consist of tunnels driven into the canyon walls approximately 60 ft. in which anchor bars were concreted in place.

Maximum lift is 600 ft. As the load must be prevented from turning, two separate hoists are used, connected to the load by means of an equalizing bar through a single pin. When two hoists are connected to the same load, they must be synchronized by some means, since if one hoist were to operate for any appreciable time at a different speed, a transfer of load would result with the possibility of fouling the lines.

The driving machinery comprises three separate engines, two being used to drive the hoist and the third for the conveying motion. Hoisting speed with load of 40 to 150 tons is 30 ft. per min., and on loads of 1 to 40 tons is 120 ft. per min. The designed conveying speed was 240 ft. per min. at all loads. Since installation, the conveying speed has been increased to 410 ft. per min. with light loads. This change has been effected without taking the cableway out of service for more than a few hours, which demonstrates the flexibility of generator-voltage control. This change has greatly increased the capacity of the cableway when handling light materials.

Cross-section showing the location of cableway, landing ledges, control stations and construction tunnels through which the pipe will be transported to the main tunnels



Adjustable-voltage control is used for the three hoisting engines. A single motor-generator set is used, rated 250 kw., 275 volts, 1,000 to 1,200 r.p.m. and driven by a 300-hp., 2,200-volt, 3-phase, 50- to 60-cycle induction motor. When hoisting, both hoist motors operate in parallel; and when conveying, the conveying motor is operated in parallel with the hoist motors. The three motors are direct-current shunt type, the hoist motors being of the adjustable-speed type rated at 175 hp., 275 volts, 225 r.p.m. when hoisting loads from 40 to 150 tons, and 900 r.p.m. when hoisting from 1 to 40 tons. The conveying motor is rated 400 hp., 275 volts, 450 r.p.m., the conveying speed being constant under both the light and heavy loads. Separate controllers are provided for each motion, hence no confusion results in the operation of the different equipments.

A rather elaborate system of multiple-control stations is provided which permits operation from any one of five stations at the loading platform and the various adits. Certain restrictions are imposed on the operators at stations 2, 3, 4 and 5 in the interest of safety. These restrictions are optional, however, and are not imposed because of any limitations inherent in the design or construction of the cableway. Only one control may be operated at a time, and once a selection is made, the remaining desks are dead.

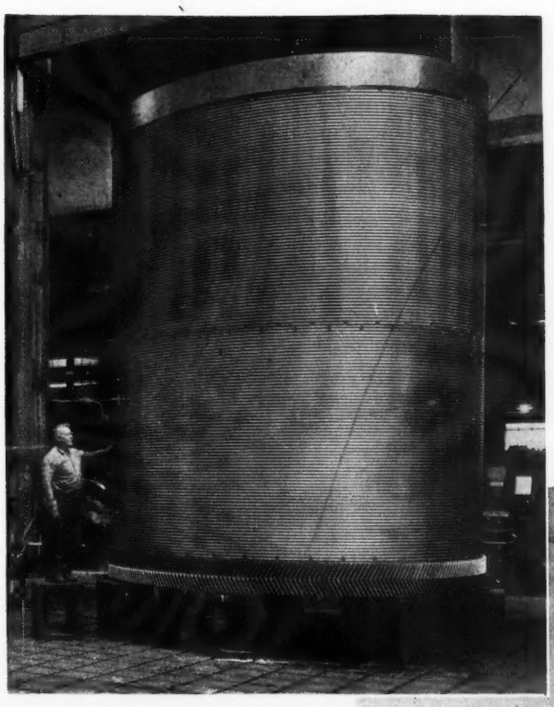
Synchronizing of two large drives of this type could be accomplished either mechanically or electrically. As it is possible to vary the speed of such motors by adjusting their fields, it was decided to secure the desired synchronizing effect by separate adjustment of the fields of the driving motors.

With this control, one hoist motor is used as the master and the other motor is regulated to conform to its speed. To accomplish this, a Selsyn generator is driven by each hoist motor. Each Selsyn generator is connected electrically to a differential Selsyn. Such an arrangement is analogous to a mechanical differential. When the Selsyn generators operate at exactly the same speed, the shaft of the differential machine remains stationary. Should one drive operate at a different speed, the shaft of the differential rotates and adjusts the regulated motor field, changing its speed to conform to the speed of the master-hoist motor.

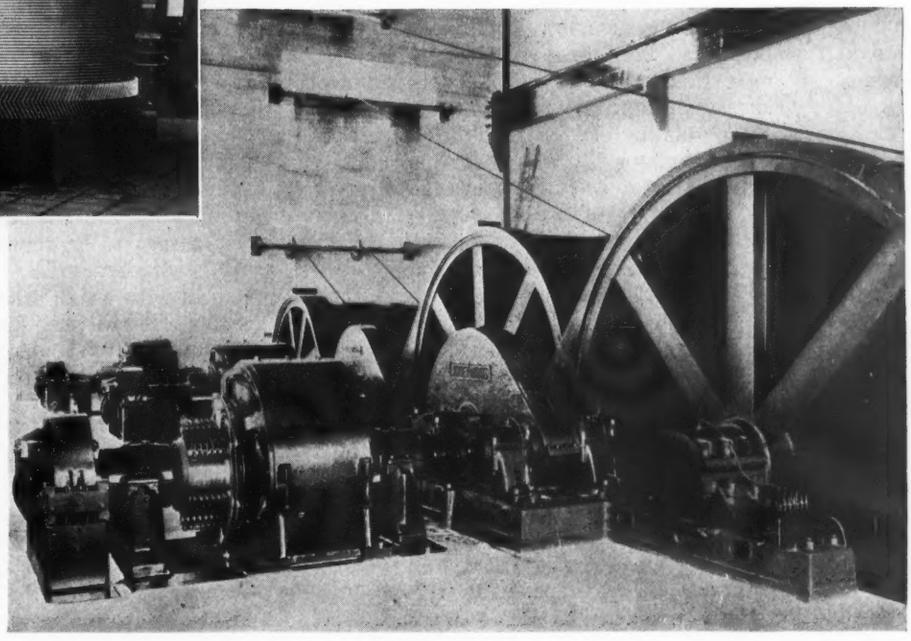
Hoisting Drums

The hoisting drums are the largest constructed for cableway use. They are 13 ft. in diameter with a face 14.5 ft. wide, built entirely of rolled shapes, electrically welded and made in two sections to facilitate shipment. The conveying drum is 8 ft. in diameted with a face of 10 ft. 2 in., and is built in a single piece. As the gear is bolted to each drum, the shaft carries only the dead weight of the drum plus the component due to cable pull, no torque being transmitted by the shaft. There are two in-haul and two out-haul ropes, each set being attached to the drum, one set being wound on as the other set is taken off. This is in contrast to the usual practice on small cableways, where the conveying ropes are of the endless type, depending for their driving force upon the friction of several turns about the conveying drum.

The cableway demonstrates the general reliability of such a machine for construction purposes over difficult terrain.



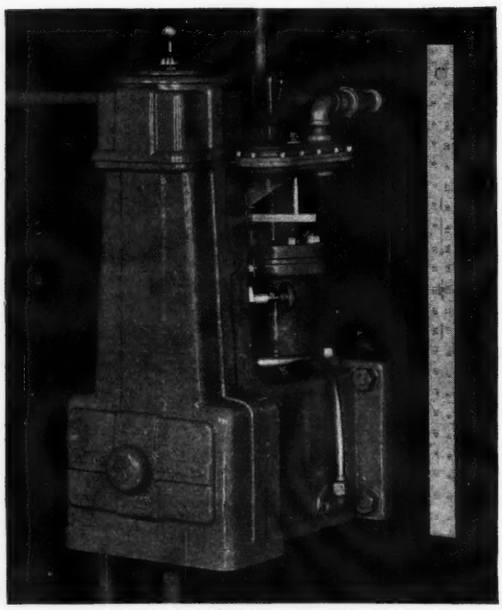
Above—Drum for one of the hoists is 13 ft. in diameter, 14.5 ft. long and of welded construction



Right—The two lifting hoists are in the foreground and the conveying hoist is in background; together they require 750-hp. motor capacity

AUTOMATIC REGULATOR

EMBODIES NEW STABILIZING PRINCIPLE



Regulator installation compared to a 24-in. rule on right

AUTOMATIC regulators have found a place in practically every kind of operation and process. For many of these applications a regulator is required that is not only sensitive to small changes in the controlled quantity and has a high speed of response but is also stable and free from hunting. These qualities have been incorporated in the new regulator of the General Regulator Corp., 50 Church St., New York, N. Y., which is a fluid-operated type adapted for the control of combustion processes, pressure, speed, volume, temperature, liquid levels and other factors.

A feature of this regulator is a new frictionless method of stabilizing which leaves the sensitive regulating mechanism free to move under the influence of the slightest unbalance of forces. This permits use of a very small diaphragm and consequently reduces lag due to inertia and contributes to quick regulator response.

The stabilizing force is obtained from the operating pressure fluid discharged through a jet at a predetermined velocity onto the arm to which the amplifying valve is responsive. The effective force of this jet, which is proportional to the amount the control pressure departs from normal, is controlled by a valve actuated by the regulating element, but this force does not act until the regulator is in motion. The velocity jet gives stability over a wide range, and the degree of stability is not affected by temperature changes or other influences which may cause erratic action.

Another feature of the regulator is its complete inclosure of working parts and compact design. It is only about 24 in. high, as shown in the photo. The regulating cylinder, stabilizing valve and relay valve are all mounted one above the other in a cylindrical passage in the center of the regulator and move in the same axis. Directly above the regulating cylinder is the amplifying valve, the balance lever and stabilizing jets. Below the relay valve in the regulator base is a simple return-motion mechanism.

This compact design permits use of a small number of light-weight parts, thus keeping friction and inertia low and permitting a high speed of response to demands of the regulated quantity. Practically all moving parts are inside the regulator casing, which permits efficient lubrication by the overflow pressure oil and protection from dirt. Two oil-pipe connections only are made to the regulator, one to supply the pressure oil, the other to return overflow to the sump tank.

Cross-sections of the regulator are shown in Figs. 1 to 3. The regulating cylinder, stabilizing valve and relay valves are clearly indicated. A rod R passes through the regulator piston, is pinned to it at A, passes down through a clearance hole in the stabilizing and relay valves and is connected to the return-motion mechanism at M. This rod connects to the relay and stabilizing valves through links B, C and D, link D being fulcrumed at F.

The restoring cam is at E and is mounted on a shaft, Fig. 2. One end of restoring arm G rests on cam E, is fulcrumed at H, and connects to bar B by link J. A flexible steel cable connects pulley L on the restoring cam shaft to the top of the piston rod of the power cylinder. Tension is maintained in this cable by a heavy spiral spring M so that the restoring cam follows operating piston movement.

Pressure to be regulated is applied to the top side of the diaphragm N, the bottom side of which is in contact with weigh beam O by a pivot rod. This beam is supported between knife edges and is weighted on the end opposite to the diaphragm. It is connected near its center, Fig. 2, by a pivot rod to a lever on the shaft S_1 (Figs. 1 and 2) that carries the regulating arm Q. In this arm is the amplifying valve that regulates the flow of oil from the regulating cylinder and it is also acted upon by two stabilizing oil jets.

In Fig. 3, pressure oil enters the regulator at T and goes to the relay-valve through port P_1 to the stabilizing valve through port P_2 and to the regulating piston through ports P_3 and P_4. Oil flow through port P_4 is restricted by needle valve V_1 so that the pressure on

top of the piston may be readily controlled by the amplifying valve, Fig. 1.

Assume the regulator to be balanced and controlling pressure and that the load changes to cause the diaphragm to rise. Then the right-hand end of lever O will rise and the left-hand end will fall a slight amount. This will turn shaft S_1 to restrict the flow through the amplifying valve and increase pressure above the regulating piston, causing it and the stabilizing and relay valves to start moving downward.

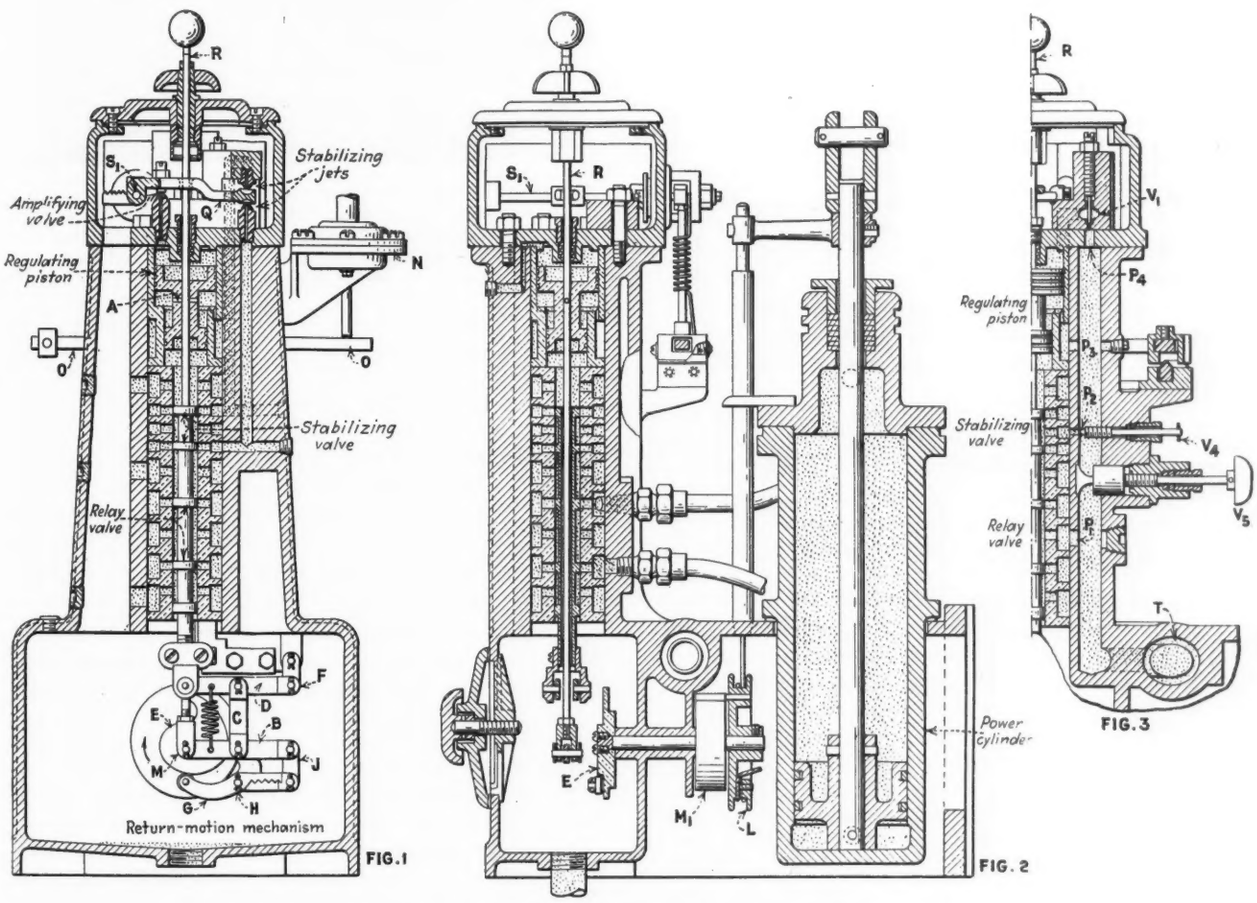
Downward movement of the stabilizing valve opens its bottom port to the pressure oil, which flows up through the outside passageway to a nozzle under regulating arm Q. An oil jet applied upward against this arm tends to restore it to its original position and prevent over-travel. Opening the bottom port of the relay valve admits pressure oil to the under side of the power piston. The top port of the relay valve is opened to discharge so that the power piston starts to move up.

Upward movement of the power piston turns the restoring cam in a clockwise direction, which pushes down the left-hand end of arm G and raises the right-hand end. This action moves the relay and stabilizing valves upward toward their neutral position and reduces the stabilizing force on the regulating arm Q. If the power piston movement has not been sufficient to supply the demand represented by the force acting on the diaphragm, then regulating arm Q again starts to move downward. This causes the regulating piston to move to a lower position. The operation just explained is repeated until the demand is supplied. For a decrease in demand, action of the various parts is the reverse.

This operation of the regulator is a smooth process and not a step-by-step action, as might be inferred from the foregoing paragraph. The result is that the rate of operation is in proportion to the rate of change of pressure under control, and the regulator does not hunt, no matter what time lag may be in the equipment under control. The degree of stabilization is adjustable from outside the regulator case by valve V_4, which controls the maximum amount of oil delivered to the stabilizing nozzles.

Valve V_5 is used to shut off the oil from the stabilizing valve and regulating cylinder when it is desired to operate the regulator by hand. When this valve is closed, moving rod R up or down by hand provides manual control of the operating cylinder with the position indicator and hand locking device.

Stability is essential to accurate regulation. In a group of regulators such as a combustion control system, the importance of individual regulator stability becomes greater. One erratic regulator in the system affects the results of the whole. Each regulator must be stabilized for the particular service expected of it and when once set its degree of stability must remain unchanged. For boiler operation these regulators may be used to control fuel feed, air flow, or furnace pressure individually, or they may be grouped under the control of a master regulator and all operations of a bank of boilers may be controlled as a unit.



Figs. 1 to 3—Cross-sections through the regulator

REFRIGERATION BY STEAM JET—II

By D. W. R. MORGAN
Steam Division
Westinghouse Electric & Mfg. Co.

LOW-COST steam, more efficient apparatus, research, and the demand for air conditioning of industrial plants and large buildings, are among the reasons for the increasing use of steam-vacuum-refrigeration. Economical application of this type of cooling basically depends upon obtaining sufficient steam at not more than one dollar per thousand pounds and necessary water at reasonable pumping costs.

It is frequently asked at what pressure the steam compressor should be operated to secure the highest efficiency? The optimum pressure approaches 125 lb. gage, and but little improvement can be expected from an operating pressure of 200 lb. as compared to 125 lb. Steam consumption increases as the initial pressure decreases. At 50 lb. gage steam consumption is 1.14 times the consumption at 125 lb. initial pressure. At 10 lb. gage operating pressure consumption is approximately 1.66 times the 125 lb. performance. Units can be designed to operate at atmospheric pressure; however, the practical limit is probably a minimum operating pressure of 2 lb. gage. There are many possible applications involving the use of low-pressure engine or turbine exhaust in hotels, public buildings, stores and industrial plants.

The supply of low-pressure steam, however, is often insufficient to produce the total refrigeration demand. In this event the additional steam may be supplied from another source, fed through a reducing valve, or a combination of steam-jet compressors may be installed designed to utilize that quantity of steam available at low-pressure, and augmented by other compressors operating at higher pressures.

It is important that dry steam be supplied to the steam-jet compressor. There is, however, no advantage in using superheated steam as it only imposes additional duty on the condenser.

Application of steam-jet compressors necessitates a thorough investigation of the steam pressure available at the unit. For example, if a turbine is designed for 125 lb. pressure, it will operate at reduced load if the steam pressure is reduced to 100 lb. This, however, does not apply to a steam-jet compressor. If the nozzles are designed for 125 lb. pressure, the apparatus becomes inoperative when pressure falls to 100 lb. unless the absolute pressure in the condenser is less than designed value. It is, therefore, most important to supply the manufacturer with information concerning the minimum and maximum pressure available. Sometimes, due to the length of line and steam supply to other sources, the pressure at the steam-jet compressor falls considerably below boiler pressure. This may result in embarrassment and considerable expense before the error is rectified.

The same word of caution applies to the condenser apparatus serving the compressor. One should study the conditions of highest water temperature, and lowest vacuum, rather than assume operating averages, particularly in this kind of apparatus where the maximum duty is generally imposed during the period of hot weather.

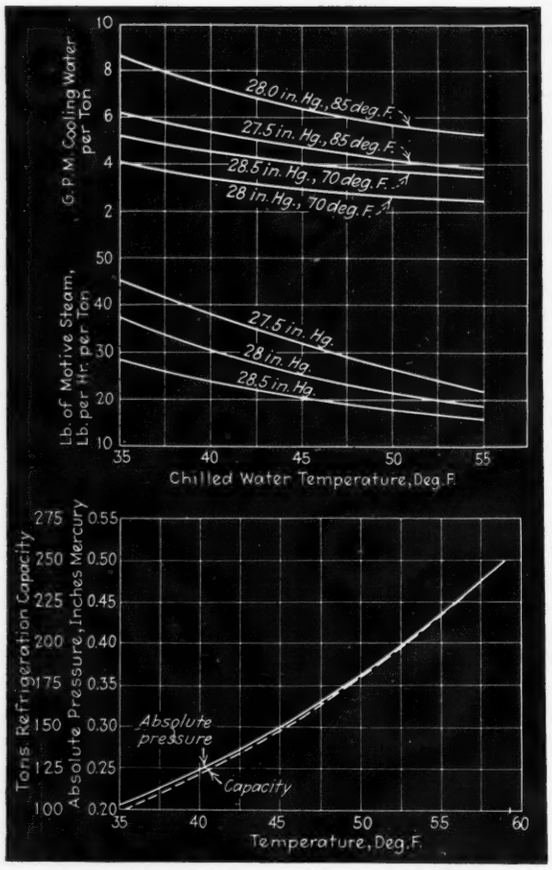

G.P.M. Cooling Water per Ton
28.0 in. Hg., 85 deg. F.
27.5 in. Hg., 85 deg. F.
28.5 in. Hg., 70 deg. F.
28 in. Hg., 70 deg. F.
Lb. of Motive Steam, Lb. per Hr. per Ton
27.5 in. Hg.
28 in. Hg.
28.5 in. Hg.
Chilled Water Temperature, Deg. F.
Tons Refrigeration Capacity
Absolute Pressure, Inches Mercury
Absolute pressure
Capacity
Temperature, Deg. F.

Fig. 1 (Top)—Steam and cooling water consumption at various chilled water temperatures and condenser pressures. Fig. 2—Variation in capacity of steam-jet unit with varying chilled water temperature.

In addition to the steam consumed by the compressor, we must add a normal amount for the steam actuated ejector used for removing air from the condenser. This steam consumption amounts to approximately 100 lb. per hr. for a 100-ton unit and approximately 200 lb. per hr. for a 200-ton unit, depending somewhat upon air leakage assumed and upon whether a closed or open spray system of cooling is employed.

Economical Performance

Fig. 1 shows the economy possible for specific conditions with an initial pressure of 125 lb. gage at the ejector, and covers a range of chilled water temperatures from 35 to 55 deg. Examination of this curve demonstrates the necessity of determining in advance what temperature of chilled water is required for a particular purpose, because the steam consumption increases appreciably as the temperature of the chilled water decreases. For instance, for a temperature of 55 deg. the compressor requires 18.3 lb. of steam per ton, whereas for 35 deg. water it will require 37 lb. of steam per ton assuming 28 in. vacuum is maintained.

COST COMPARISONS

Table I—100-Ton Unit

	Steam Ejector	Freon Compression
Original Cost		
Refrigerating unit installed	$5,000.00	$14,500.00
Cooling tower installed	2,660.00	.....
Steam and water piping	500.00	.....
	$8,160.00	$14,500.00
Operating Cost		
Power:		
52,536 kw.-hr. at 2c	.....	1,050.72
44,000 ton hr. at $0.00731 per ton for cooling tower	$321.64	.....
Water:		
5,280,000 gal. at $.095	.....	501.60
792,000 gal. make-up	75.25	.....
Refrigerant replacement	.....	125.00
Maintenance	75.00	50.00
Lubrcant	1.00	5.00
Steam at $1.00 per M lb	1,540.00	....
	$2,013.84	$1,732.32
Fixed charges at 12%	979.20	1,740.00
	$2,993.04	$3,472.32

Table II—50-Ton Unit

	Steam Ejector	Freon Compression
Original Cost		
Initial cost of refrigerating unit installed	$3,200.00	$9,500.00
Cooling tower, 300g.p.m. capacity	1,490.00	.....
One pump plus steam piping	400.00	.....
	$5,090.00	$9,500.00
Operating Cost		
Power:		
26,268 kw.-hr. at 2c. for compressor	....	$525.36
22,000 tons at $.00731 for cooling tower	$160.00	.....
Water:		
2,640,000 gal. at $.095 M gal.	....	250.80
396,000 gal. make-up	37.62	.....
Refrigerant replacement	.....	70.00
Maintenance	60.00	50.00
Lubricant and miscellaneous	1.00	5.00
770,000 lb. steam at $1.000 per M lb.	770.00	....
	$1,029.50	$901.16
Fixed charges at 12%	610.80	1,140.00
	$1,640.30	$2,041.16

Table III—25-Ton Unit

	Steam Ejector	Freon Compression
Original Cost		
Initial cost of unit installed	$2,500.00	$6,500.00
Cooling tower including pump, installed	1,250.00	.....
	$3,750.00	$6,500.00
Operating Cost		
Power:		
13,134 kw.-hr. at 2c. for compressor	....	$262.68
11,000 ton hr. at $.00731 (cooling tower)	$80.41	.....
Water:		
1,320,000 gal. at $.095	.....	125.40
198,000 gal. make-up at $.095	18.81	....
Refrigerant replacement	.....	50.00
Maintenance and Miscellaneous	50.00	40.00
385,000 lb. steam at $1.00 per M lb.	385.00	.....
	$534.22	$478.08
Fixed charges at 12%	450.00	780.00
	$984.22	$1,258.08

The curves further illustrate the necessity of analysis to determine the economical amount of condenser surface and cooling water. For example, with 35-deg. chilled water, it requires 28½ lb. of motive steam per ton when maintaining a vacuum of 28½ in. as compared with 45½ lb. of motive steam per ton when maintaining a vacuum of 27½ in. This indicates the possibilities for a specific operating condition, and the values used would not be applied over the entire range of cooling.

Fig. 2 shows how capacity and evaporator pressure vary with the required chilled-water temperature.

Tables 1, 2, 3 give representative values of first cost, cost of operation, and maintenance, prepared by the National District Heating Association, for 25-, 50- and 100-ton steam-jet and Freon compressor units.

In the estimate of first cost, air washers, fans and ducts are not included.

Operating costs are based on 800 hr. of operation a year with an annual load factor of 55 per cent. The chilled-water temperature required is 50 deg. and the average temperature of condensing water is taken at 85 deg. Steam for the steam-jet compressor is supplied at 125 lb. pressure at a cost of $1.00 per thousand lb. Electricity for the Freon compressor is taken at 2 cents a kw.-hr. Fixed charges are figured at 12 per cent of the first cost.

With these conditions, the steam-jet compressor requires 35 lb. of motivating steam per ton per hr. and 6 g.p.m. per ton of make-up water to the cooling tower. The Freon compressor requires 1.194 kw.-hr. per ton of refrigeration and 2 g.p.m. per ton of cooling water.

FOR THE LOVE OF PETE,

WHY . . .

. . . were floor drains installed at the high points in the boiler room floor?

. . . were wet return lines from the heating system and boiler blow off lines buried under a concrete floor underlaid with cinders?

. . . were concrete trenches for boiler feed piping installed with no provision for drainage?

. . . were terra cotta 2300 volt cable ducts buried in cinders and graded downward to a point between manholes?

. . . was the blowdown water from the continuous blowdown system piped to the feed pump suction?

. . . was a domestic hot water heater installed with its steam supply taken from the high pressure header when waste exhaust steam was available?

. . . were malleable iron low-pressure fittings installed in the auxiliary boiler feed line?

. . . were boiler settings laid up with no expansion joints?

. . . were flat baffle tile installed at an almost vertical angle with no support and expected not to slide?

. . . did the access doors to the boiler passes open dead center on banks of tubes?

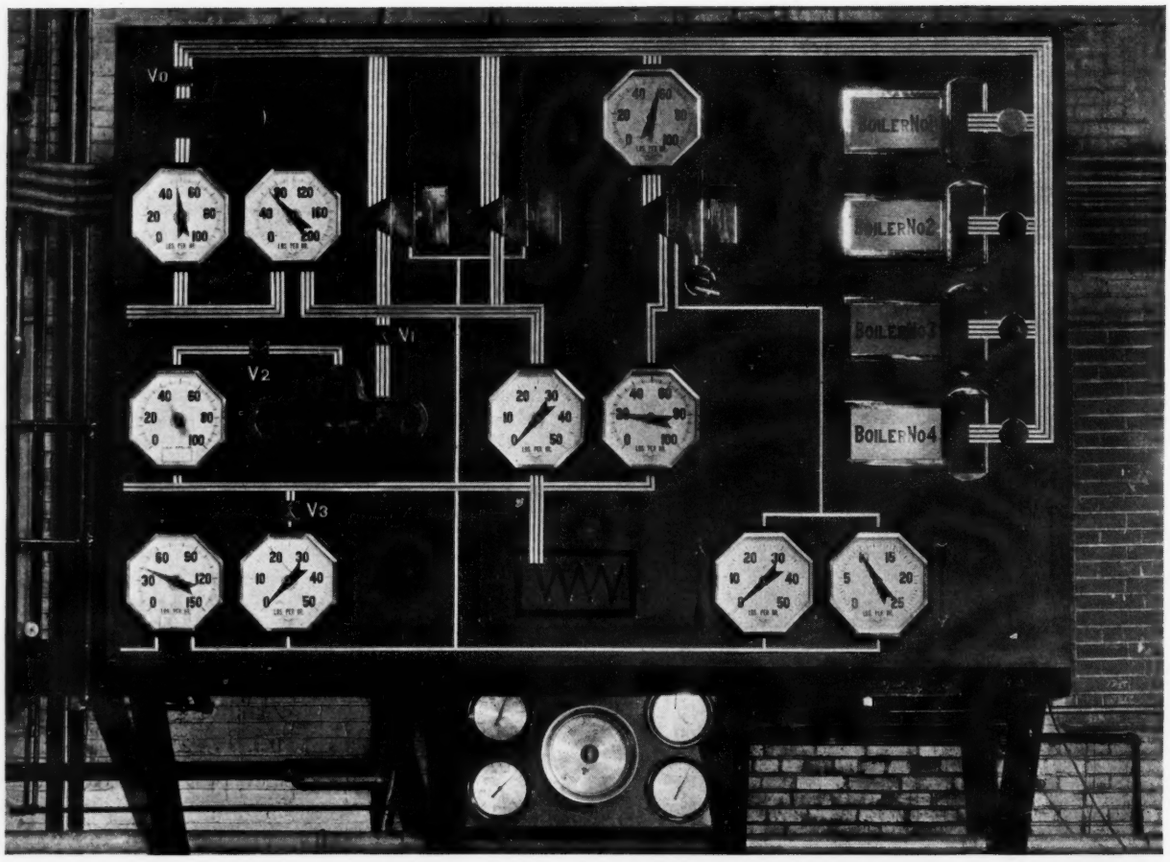
. . . were uptake dampers installed so that an 8 ft. lever was required to move them?

. . . were boiler flow meters, flue gas temperature recorders and CO_2 machine installed 60 ft. from the fireman's base of operations?

. . . did the factory superintendent overlook 60 per cent combustible in the stoker ash?

. . . did the factory superintendent think that a man with no previous operating experience could be made into an operating engineer in thirty days?

Waynesboro, Va. S. H. COLEMAN



Schematic steam-flow panel helps engineer visualize operation

STEAM FLOW

WHERE FROM . . . WHERE TO . . . HOW MUCH

By F. W. RABE
Assistant Chief Engineer,
Anheuser-Busch, St. Louis

IN INDUSTRIAL plants generating by-product power, efficient operation depends largely upon the engineer's ability to visualize the over-all requirements for process steam at various pressures, as well as requirements for electricity. Isolated indicating and recording gages placed at random give at best a scattered picture of the whole. To help operating engineers in the Anheuser-Busch power plant secure an over-all picture, the schematic steam-flow board, shown above, was installed. With the steam-flow requirements visualized in this way, the engineer can load the turbines to secure highest possible economy.

Recent additions to the Anheuser-Busch plant have brought its generating capacity up to 13,000 kva. There are two 4,000-kva. Allis-Chalmers non-condensing turbines, and one 5,000-kva. General Electric condensing turbine-generator. The two small units are arranged to bleed at 140 lb. pressure and exhaust at 5 lb. pressure, supplying steam to a Ruths accumulator and steam for low-pressure process. The larger turbine is arranged for bleeding at 35 lb. pressure and at 5 lb. pressure. The 5,000-kw. unit is also arranged so that it can use steam at 5 lb. pressure whenever there is an excess supply from the exhaust of the two smaller turbines.

Steam is generated in Springfield boilers at 460 lb. pressure and 600 deg. Reducing valves are installed so that 140-lb. steam is available through a desuperheater from the high-pressure line. Likewise, 5-lb. pressure steam is available through a reducing valve from the 35-lb. pressure header, and 35-lb. pressure steam is available from the Ruths accumulator.

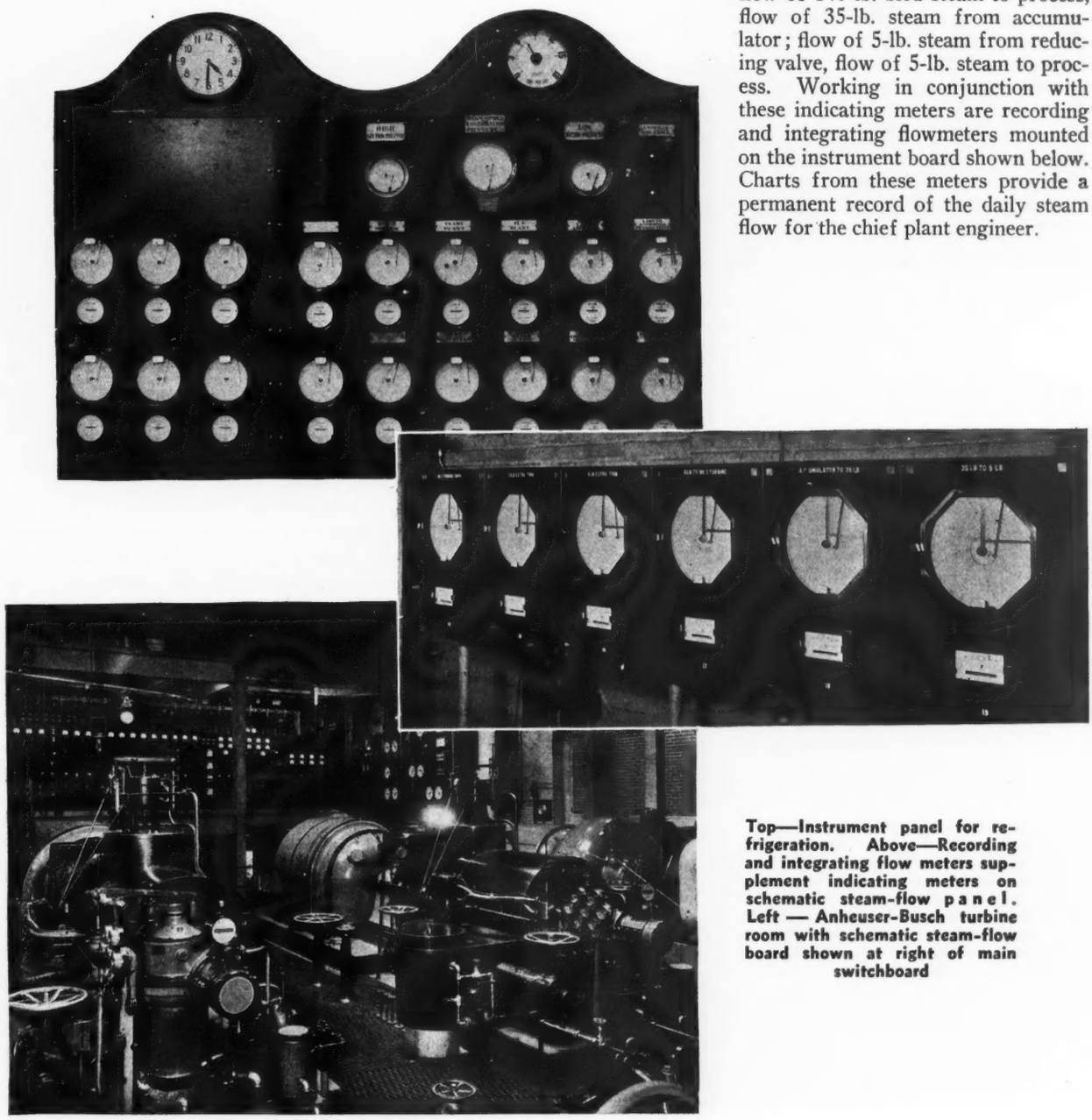
The idea of a schematic layout on an instrument panel is not new, it having been used on switchboards

and panels for operating remotely controlled valves. Its application to a steam-flow board is, however, believed to be a new one. The board is 12 ft. long, 8 ft. high, and is made of boiler plate $\frac{3}{16}$ in. thick. It is mounted 4 ft. 6 in. from the end wall of the turbine room on the switchboard operating level. A walkway made of floor plates was built behind the board to permit repairs and adjustments.

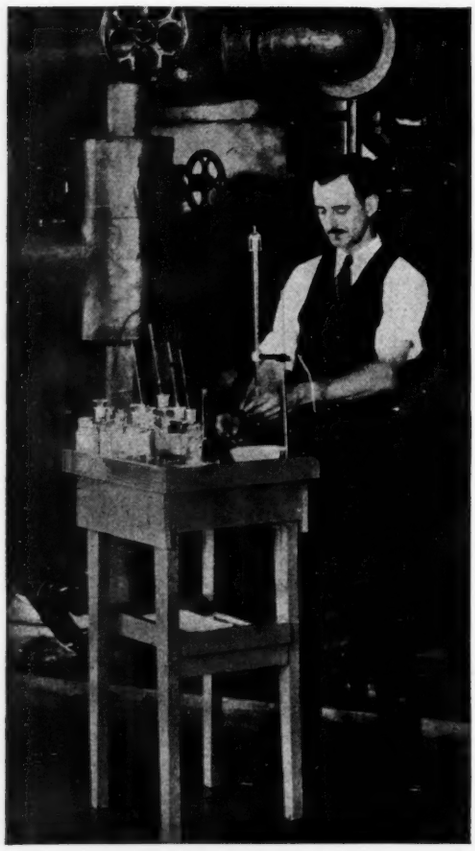
The board is finished in black, which forms an excellent background for the chrome-plated schematics of equipment and brushed copper steam lines. The international schematic notation indicating equipment has been used throughout, and the copper bar system for steam lines fits in with this arrangement. The copper bars are $\frac{1}{2}$ in. wide and spaced $\frac{1}{4}$ in. apart, the number of bars indicating the different steam pressures used in the plant. Thus, four bars represent steam at 460 lb. pressure, three bars 140-lb. pressure steam, two bars 35-lb. pressure steam, and one bar 5-lb. pressure steam.

The boiler panels, Nos. 1, 2 and 3, are lighted by bulbs actuated by a hand switch on the firing floor. The light for No. 4 boiler panel is at present controlled by a mercoid switch operated by the pressure gage on No. 4 boiler gage board. The light operates when the boiler pressure reaches 400 lb. This arrangement shows the engineer at all times which boilers are in operation. The circular disks A, B, C and D indicate steam-flow meters measuring the output from each boiler. These meters are mounted on the boiler gage boards on the firing floor.

Indicating Republic flow-meters on this panel-board are flush mounted with 15-in. hexagon type casings. These meters indicate the steam flow as follows: Flow to 5,000-kw. condensing turbine, bled steam at 35-lb. pressure, 5-lb. steam from and to the 5,000-kw. unit, flow of 140-lb. steam to high-pressure heater, flow of 140-lb. steam from reducing valve, flow of 140-lb. bled steam to process, flow of 35-lb. steam from accumulator; flow of 5-lb. steam from reducing valve, flow of 5-lb. steam to process. Working in conjunction with these indicating meters are recording and integrating flowmeters mounted on the instrument board shown below. Charts from these meters provide a permanent record of the daily steam flow for the chief plant engineer.



Top—Instrument panel for refrigeration. Above—Recording and integrating flow meters supplement indicating meters on schematic steam-flow panel. Left — Anheuser-Busch turbine room with schematic steam-flow board shown at right of main switchboard



Author makes Winkler Test in the plant alongside the deaerating heater

MEASURE OXYGEN This Way

By H. S. LEWIS
Cochrane Corporation

This article was written to a specification: "Tell the operating man who is not a chemist exactly how to run a Winkler test." It does just that, clearly, dependably, step by step. Dissolved oxygen is the prime cause of corrosion. Make your own Winkler tests to spot its source and cure the trouble

RECENT research work on the Winkler test for oxygen dissolved in water has led to appreciable refinements and has also demonstrated certain limitations. The degree of accuracy of the test is now better defined, and the influences which tend to destroy its reliability are better known, together with the procedure and precautions which are favorable to correct results. The Winkler test is extremely sensitive, but errors may become greater than the amount of oxygen in the water unless certain precautions are taken.

The purpose of this article is to apply the results of the research work so that the operating engineer may obtain correct results, even though he may not have all the facilities of a chemical laboratory or the specialized skill of a trained chemist to help him.

How to Sample

First, select a suitable point in the water current for withdrawing the sample to be tested. The sampling connection, preferably including a ¼-in. brass nipple with a gate valve, may be inserted in the pump suction line leading from the heater. To avoid taking in air, the sample should be withdrawn from a point at which the water pressure is greater than that of the atmosphere. If the sample is drawn from the discharge side of the boiler feed pump, raw-water pollution is a possibility, if the pump glands are sealed with cold water. Remember that three drops of water of high oxygen content added to a 280 ml.[1] sample of zero oxygen content will cause oxygen to be registered by the Winkler test. However, samples taken from the pump discharge will serve to show the amount of oxygen entering the boilers, provided the contaminating leakage has been well mixed in the stream where sampled.

To the brass nipple with gate valve, which may remain in the system as a permanent sampling connection, a copper cooling coil with a throttle valve and short length of copper tubing at the outlet end should be attached. The coil should comprise approximately 12 lineal ft. of copper tubing. Copper or brass is recommended, as neither will affect the water chemically.

The use of rubber tubing as a connecting piece is objectionable because most rubber tubing contains sulphur, which acts as a reducing agent. If the true oxygen content of the feedwater is 0.06 ml. per liter, the test may show 0.02 ml. per liter or less, depending upon the quantity of sulphur in the hose.

The use of a cooling coil made of ordinary wrought-iron pipe also is objectionable because the oxygen in the water to be sampled will combine with the iron, thus reducing the quantity of oxygen finally to be measured. The coil may also give off rust, which interferes with the accuracy of the Winkler test.

The samples for testing may be collected in a glass-stoppered bottle holding 280 ml. Of this quantity, 200 ml. are used for testing and 80 ml. may be used for rinsing the graduate and stirring rod used in the test, while the test dish is to be rinsed with distilled water. The rinsing procedure will insure greater accuracy.

Prior to beginning the collection of the sample, the

[1] "ml." is the abbreviation for milliliter, equalling cubic centimeter or 1/1000 liter. Thus a reference later to 0.06 ml. of oxygen per liter of water means 60 parts per million by volume.

coils should be flushed out thoroughly, say for 5 min., with the water to be sampled to remove any dust, sediment or foreign matter. This procedure will also give the operator a more representative sample.

When the coil has been cleaned thoroughly, the end of the outlet tube delivering the cooled sample should be inserted to the bottom of the 280-ml. glass-stoppered bottle. The rate of flow may be adjusted to approximately 280 ml. per min., so that after 6 min. the bottle will have been overflowed and its volume displaced six times. However, in collecting the sample the gate valve on the hot-water side of the coil must be open wide and only the valve on the cooled-water side must be throttled to regulate the rate of flow.

The rate at which the water is withdrawn does not affect the final oxygen content of the sample if the sample is properly cooled so that no flashing occurs.

In withdrawing the sample, particular care must be

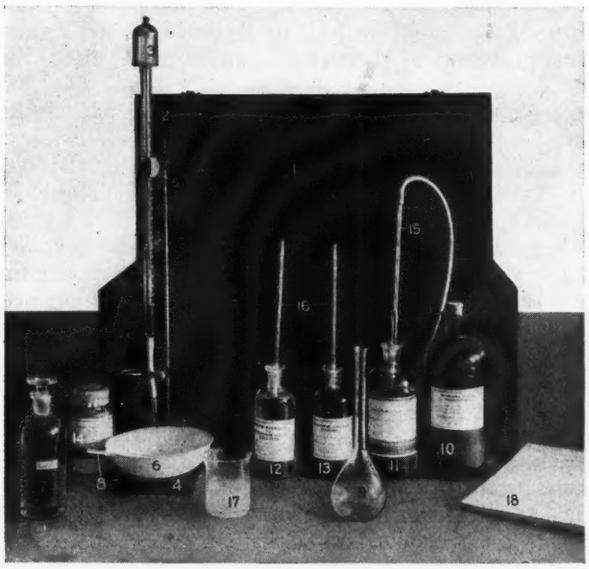


Fig. 1—Winkler Test Kit

1—Test case—2—Two Burettes, 25 ml. and Attachments. 3—One burette cap. 4—One burette stand. 5—One clamp. 6—One evaporating dish. 7—One glass-stoppered sampling bottle, 250 ml. 8—Two stirring rods. 9—One volumetric flask, 200 ml. 10—One quart bottle sodium thiosulphate (standardized N/100 solution). 11—One pint concentrated hydrochloric acid. 12—One half-pint bottle sodium hydroxide and potassium iodide solution. 13—One half-pint bottle manganese chloride solution. 14—One bottle soluble starch (powdered). 15—Two pipettes, 5 ml. 16—Three pipettes, 1 ml. 17—One beaker, 150 ml. 18—One hundred analysis blanks.

exercised to prevent flashing. In passing water at steam temperature at one pressure to a lower pressure, some of the water will flash into steam, which will liberate a part or all of the oxygen contained in the water unless the necessary precaution is observed of having the valve on the hot-water side of the coil wide open, and the discharge valve throttled. Flashing may be detected by the appearance of bubbles passing through the sampling bottle, but in some cases the bubbles are very small and only a careful examination will reveal their presence. Large or small, they can be eliminated by gradually throttling down at the outlet valve.

For cooling the sample, the copper coil may be placed in a bucket of cold water. Ice in the water is desirable, but if it is not available, cold water may be allowed to run into the bucket and overflow at a slow rate. This will cool the sample to a proper temperature.

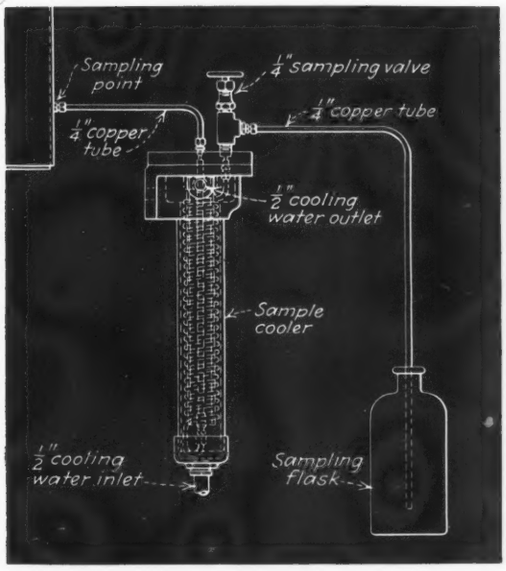
In research on this subject, samples for analysis have generally been collected at a temperature below 60 deg. F. Low temperatures are desirable, as they favor a greater degree of accuracy, but in field work they may be impractical, as oftentimes neither ice nor refrigerating equipment is available. Therefore, for field work 85 deg. F. has been proposed as a satisfactory titrating temperature, which can be obtained with the ordinary copper coil cooled by city water.

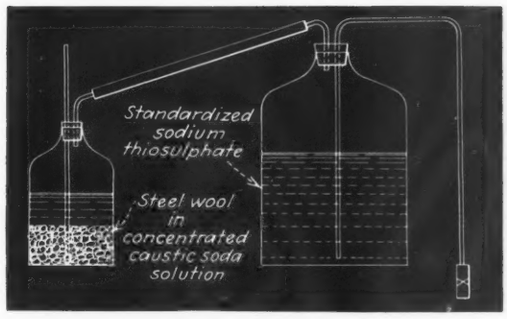
If a sample is titrated at too high a temperature, only a portion of the true oxygen content will register. For example, at 100 deg. F. the sample must contain 0.07 ml. of oxygen per liter for any oxygen to register.

Also, the hotter the sample, the less oxygen is registered. On the other hand, at 60 deg. F., a test of water containing absolutely no oxygen will show as much as 0.013 ml. per liter (when using Baker's soluble starch) due to the oxygen dissolved in the reagents, which quantity should be deducted from the result if the test is made at that temperature. At 70 deg. F. the amount to be subtracted is approximately 0.01 ml. If the sample is titrated at 85 deg. no correction is required.

To proceed with the Winkler test, assume that the sample has been properly drawn at the correct temperature. The sampling bottle having overflowed its volume six times over, the copper tube is then slowly

Fig. 2 (Top)—Sampling water cooler and details of sampling connections. Fig. 3—Sodium thiosulphate solution deteriorates rapidly unless protected. Sketch shows hookup for protective caustic-air wash.





withdrawn while the sample is still running and the glass stopper is quickly inserted. To prevent entrapping air within the bottle, the bottle should be held at a slight angle while inserting the stopper. A still better method is to grind a rounded tip on the glass stopper.

To the sample add 1 ml. each of manganese chloride and sodium hydroxide-potassium iodide solution, inserting the tip of the pipette in each case below the surface of the water. If, after replacing the stopper, an air bubble is entrapped, discard the sample.

The precipitate in the bottle should be distributed thoroughly by turning the bottle over and over and the contents should be allowed to settle for about 3 min. At the end of that time, or when all of the precipitate has settled to the lower third of the bottle, 5 ml. of concentrated hydrochloric acid is added in the same manner as before. For drawing up the hydrochloric acid into the pipette, it is advisable to attach a rubber tube about 12 in. long to the end of the pipette, to avoid drawing acid fumes into the mouth. After adding the acid to the sample replace the stopper and rotate the bottle until all precipitate has dissolved.

When solution is complete, the sample is fixed and there is no further danger of pollution by air. The glass stopper may be removed and the temperature of the sample recorded. If this exceeds 85 deg. F. the sample should be cooled to that point.

Titration of the sample is the next step and should be conducted in a good natural light. Titration in artificial light leads to error.

First, after using a portion of the sample to rinse the graduate, measure out 200 ml. of the sample and pour it into the test dish. Add 1 ml. of starch solution. If no oxygen is present, the sample remains colorless, but if a blue color appears, add standardized sodium thiosulphate solution from the burette, drop by drop, at the same time stirring the sample, until the blue color disappears. Multiply the total amount of thiosulphate used in ml. by a factor, which should be written on the label of the thiosulphate bottle, to get the quantity of oxygen in ml. per liter.

When testing for larger quantities of oxygen (1 ml. per liter or more) 1 ml. of potassium iodide solution should be added to the sample following the manganese chloride and sodium hydroxide-potassium iodide solutions. After the precipitate has settled, the bottle should be reagitated and the precipitate again allowed to settle. A deep yellow or brown color will result. Before adding starch, most of the yellow color should be reduced to a very faint yellow by adding a measured quantity of sodium thiosulphate. When but a faint yellow color remains the starch solution should be added. The final blue is then removed with sodium thiosulphate as before. *The total amount of thiosulphate used, measured in ml., when multiplied by the factor on the label of the thiosulphate bottle gives the amount of oxygen in ml. per liter.*

Oftentimes, the water contains impurities which produce a blue color in the Winkler test as does oxygen. The presence of these substances can be detected by an interference test. The most common interfering substances are rust, nitrates, organic matter and iron salts. Also red lead, when not properly prepared with white lead and linseed oil, may be washed from pipe joints and cause interference.

The test for interference causing high oxygen readings is similar to the oxygen test, except that the manganese chloride is added to the sample *after* the hydrochloric acid has been added. If, upon adding starch, a blue color appears, an interfering substance is present. In this event the water should be permitted to run from the sampling connection for about 30 min., and if interference still persists the sample must be discarded. A deduction or correction for the interference cannot be made with any certainty.

On the other hand, if sodium sulphite or ferrous sulphate comes into contact with the feedwater, too low values for oxygen content will be indicated. The same is true if the sample is collected through sulphur-cured rubber tubing or if the sodium hydroxide-potassium iodide bottle has a sulphur-cured rubber stopper.

The presence of a reducing agent, which causes low oxygen readings, may be detected by a test similar to the Winkler test. If, upon adding starch, the sample remains colorless, it should be titrated with a one-hundredth normal iodine solution. If no reducing agent is present generally one drop of the iodine solution will impart a blue color to the sample. Should more than one drop of the iodine solution be required, the total amount of iodine used in ml. multiplied by the factor used with the sodium thiosulphate, will give the total amount of reducing agent present in equivalent ml. per liter of oxygen. All tests for interference should be made at the temperature at which the sample is titrated for oxygen.

Regarding the age of chemicals, manganese chloride, sodium hydroxide-potassium iodide and hydrochloric acid solutions are not affected, provided that they are well stoppered and kept dust free. However, any of the chemicals are very easily contaminated by interchanging pipettes or by using unwashed pipettes. Sodium thiosulphate is affected by carbon dioxide and should be standardized every two weeks. However, it may be protected from the carbon dioxide in the atmosphere by the use of the caustic air wash as shown by Fig. 3. This caustic air wash is recommended for plants having no chemical laboratory. As for the starch solution, it is best to make up a new supply daily or for each set of tests to be run.

REAGENTS REQUIRED FOR THE WINKLER TEST AND FOR THE STANDARD INTERFERENCE TESTS:

A. Manganese chloride solution—40 grams of $MnCl_2$ $4H_2O$ dissolved in water and diluted to 100 ml. If solution contains suspended matter, filter.

B. Sodium hydroxide—potassium iodide solution—42 grams of NaOH dissolved in water. Add 10 grams KI and dilute to 100 ml.

C. Potassium iodide solution, for raw water. 30 grams of KI dissolved in water and diluted to 100 ml.

D. N/100 (one-hundredth normal) sodium thiosulphate solution (1 ml. in a 200 ml. sample corresponds to 0.28 ml. oxygen per liter).

E. Concentrated hydrochloric acid.

F. Starch solution. Make up new supply daily. To 2 grams of Bakers soluble starch (about ½ teaspoonful) add a little cold water, mix into a paste, and add 100 ml. boiling water and stir until the starch is dissolved. Allow to cool to room temperature before using.

G. N/100 Iodine solution.

The above chemicals are obtainable from water testing laboratories ready made up for the Winkler test. The thiosulphate requires frequent restandardization as it changes in strength on exposure to carbon dioxide.

PRACTICAL AIDS TO OPERATION

Valve and File Made Into Valve-Seat Facer

WHEN cylinder heads were pulled during the annual overhaul of a 200-hp. gas engine driving one unit of an oil pumping station, the valves and their seats were found to be pitted and scored beyond regrinding. New seats were not available and the unit was needed in service. It appeared necessary to send the heads to a machine shop to have the valve seats refaced. This would have cost $12 per head, and would have caused considerable delay in getting the engine back into service. This did not appeal to the assistant chief engineer, who devised another more economical and speedy way out of the difficulty.

He selected a discarded valve with a true stem and made hacksaw cuts across its beveled face to a depth slightly more than half the thickness of an 8-in. mill file. The metal was then removed between the cuts to make a shallow slot or notch into which the file would fit snugly, as in the photograph. With the file placed as shown, the valve was rotated on the seat with a bit-brace and the standard grinding yoke. This quickly removed the pits and ridges, leaving only minimum or touch-up grinding to put the seats into condition.

By deepening the slot slightly on what would be the leading edge of the file, all cutting was done by the trailing side of the file teeth, thus preventing chattering.

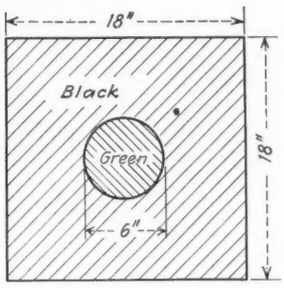
The improvised seat facer did not, of course, perfect a valve seat which was out of true or warped. After the high side of the seat was determined with feelers and a new valve, it was possible to rotate the file through an arc to file away the high section. Thus the seat could gradually be brought back to condition where final grinding would again put it round and in line with the valve guide.

One workman working steadily with the improvised reamer was able to rough down the seats as fast as his mate could finish-grind them. The four heads were pulled, valves ground and ports refaced in the time other members of the station crew were renewing piston rings and tightening rod and main bearings.

Longview, Texas. ELTON STERRETT.

Painted Marker Shows When To Turn on Lights

ONE OF the operator's duties at our station is to energize a portion of the city's street light circuits, and to notify other substations to turn on the balance of the street lighting. This operation is performed at a certain degree of darkness, rather than according to any astronomical schedule. As the installation of a photo-electric alarm or control would have been rather expensive, a simple means was devised to determine the exact time at which the street lights should be turned on.



Across the alley from the station is a barn, the wall of which can be seen from the engine room through a window. An area about 18 in. square on the wall of the barn was painted black, with the exception of a 6 in. diameter circle in the center of the square. This center was painted dark green.

A street-light system following the astronomical schedule should go on at 15 min. after sundown. We experimented with our painted marker on clear days, and adjusted the shade of green in the center portion so that at about 10 min. after sundown, it was not possible to distinguish the circle in the square, because the two dark colors blended in the dusk. This gives the operator five minutes to call the other substations, and notify them of the time to close circuit switches.

The device will work for any kind of a day, cloudy or clear, as the blending of the colors depends entirely upon the outdoor illumination. It was discovered also that the artificial lighting in the engine room did not interfere with the indication from the marker.

Topeka, Kan. O. K. JOHNSON.

Hydro-Unit Test Made Without a Tachometer

THE method used in checking settings of a speed relay mounted atop a generator shaft in an automatic hydro-electric plant may be of interest. There were three sets of relay contacts: Restart contacts set at 85 per cent speed to prevent restarting until the machine had slowed

down sufficiently to insure proper sequence in starting, synchronizing contacts set at 96 per cent speed to complete the circuit to close the generator breaker for self-synchronizing by connecting the generator to the system, Overspeed contacts set at 128 per cent to shut the machine down should it overspeed.

Arrangements were made with another hydro station upstream to tie one of their machines to ours through a transmission line, and with both fields separately excited to bring them to speed together. Separate excitation using the motor-generator set left the direct-connected exciter free on our machine. This was separately excited from the control battery, and a 150-volt voltmeter was connected across its armature. The upstream station controlled speed and voltage of the generators, holding the speed in synchronism with the system by means of their synchroscope, while we adjusted the field of the separate exciter to give 100 volts at the armature corresponding to the 100 per cent speed.

The upstream station operator then raised the speed until the overspeed contact closed while we watched the voltmeter which now acted as tachometer. The overspeed contacts closed when the voltmeter indicated 128, which was equivalent to 128 per cent normal speed. The speed was then lowered to synchronism and we read 100 volts to check calibration. Continuing to lower it, we read 96 volts when the synchronizing contacts closed and 85 volts when the restart contact closed. Running the speed up and down several times, checking at synchronism each time, gave us a very accurate test of the speed relay.

We were also able to adjust the voltage regulator while running as a synchronous condenser and set the voltage adjusting rheostat at such a value that the generator would supply its share of wattless current when it was tied automatically to the system. The phase rotation of the generator was also checked at this time.

In connecting current and potential transformers, we followed the phase rotation marked on the print, and by tracing the main leads back to the generator winding and knowing the direction of the rotation of the water wheel we were able to assure proper operation of power-factor meters, relays and such devices.

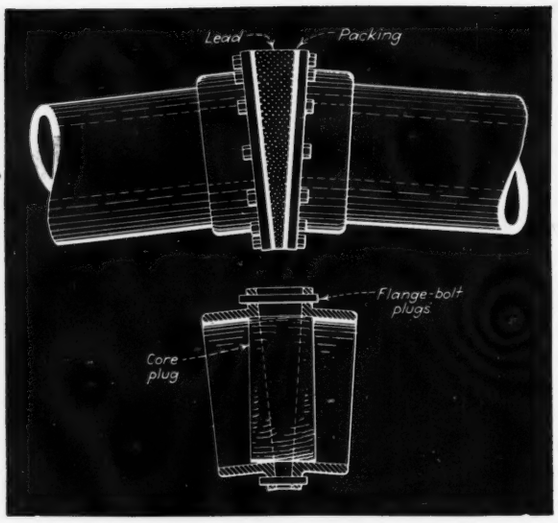
The machine started automatically two hours after the first attempt. Governor setting was responsible for it tripping on the first trial. After a three-hour run, the unit was turned over to the system operator. From then on we got it at odd hours for final adjustment of the various relays.

Montague City, Mass. MAX PAFENBACH.

Makes Pipe Angles to Suit Any Turn

ON CONSTRUCTION projects out in the wide-open spaces the engineer must frequently get results without access to material available in organized centers. I have installed wood- and steel-pipe lines running them around canyons and rock cuts like a snake's back. In such cases a bend fitting is frequently overlooked or a 45-deg. angle will not serve the purpose. This does not bother me any more for I make my own from lead cast to the required form.

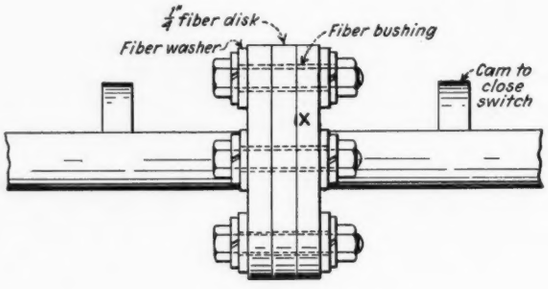
A lead-wedge with pressure tight rubber gaskets or other packing will give you any turn or bend desired in an emergency. Make a wooden core plug to go into



the pipe and permit the two flanges to be tilted to the desired angle. When the core is in place, set the pipe at the desired angle and securely block it in that position. Plug the flange bolt holes with wooden plugs running through the two flanges. Wire a piece of sheet asbestos around the collars of the flanges to complete the mold. To stop seepage of molten lead from the mold, any small holes may be stopped with fireclay mixed into a stiff putty with a little oil, or, if this is not available, asbestos or other material may be used. Build dry earth or sand up around the work, leaving the pouring hole clear above.

To make a good job, the lead casting must be made in one pour. When the casting has cooled, it may be removed by moving the pipe. Any imperfections can be taken off the casting. When the joint is made, a packing ring is placed between each flange and the lead. Before pouring the casting or any other molten metal job, warm the work, or otherwise insure freedom from moisture, or the metal may be blown from the mold and cause painful burns.

Vancouver, B. C. S. H. COOKE.



Fuses Blown "Mysteriously" By Defective Bushing

ALL KINDS of faults develop in electric machinery to cause blowing of fuses, some of them very mystifying, at least for a time. A fault, if it stays, can usually be quickly located by a capable maintenance man, but the difficulty in some cases is that when the fuses blow the cause is removed temporarily.

In a case of this kind in my experience fuses blew

periodically on an elevator motor. No cause could be found for the trouble in the equipment, either mechanical or electrical. Insulation tests made with a voltmeter showed only one or two volts throw, which with this meter indicated an insulation resistance of from three to seven megohms for the motor and the control wiring. This did not look much like a weak spot in the insulation, but as I afterward found, there was one.

The reversing switch was thrown by two cams on a shaft that rotated through about 360 deg. The shaft had an insulated coupling between the two cams, as in the figure, to prevent short-circuiting the switch. Between the two halves of the coupling was a $\frac{1}{4}$-in. fiber disk. A fiber bushing on each bolt passed completely through the coupling and extended far enough on each side for a fiber washer to be placed over each end. Thus, each bolt was completely insulated from the coupling without a break in the insulation.

One day when inspecting the equipment after a fuse had blown, I noticed a little black speck on the edge of the fiber disk, as at *X* in the figure. When I attempted to pick the speck off with the point of a knife, I found it lead to a cavity inside the fiber disk. Apparently one of the fiber tubes had been defective when first installed and current leaking through the defect carbonized a path that caused a short circuit. The resulting flash cleared the carbon temporarily and left nothing to indicate the cause of the trouble. This process kept repeating until it burned to the outside and left the telltale little black speck. The coupling was so badly burned on the inside that a new switch shaft had to be installed.

New York City. M. H. WEAVER.

Cause of Knock in Duplex Pump

A DUPLEX pump had been operating for several years satisfactorily taking water from a zeolite water softener and delivering it against 80 lb. pressure. This pump, controlled by a pressure governor, took steam at 100 lb. and exhausted it into a closed heater against 8 lb. pressure. When it became necessary to renew the cylinder linings in the water end, the steam cylinders and pistons with their rings were inspected and found in good condition. The steam valves were also inspected for leakage, and necessary adjustments were made in their settings.

After this outage the right-hand piston, when moving slowly from the head end, would stop about mid-stroke, reverse direction for a short distance and then resume its normal stroke to completion. Its travel on the opposite stroke was normal as was also that of the other piston on both strokes. As further outage of the pump at this time was objectionable, and as no immediate detrimental results were experienced, it was permitted to keep the unit in service for some weeks.

While operating in this manner, an inexperienced operator on the water softener caused a quantity of zeolite to be dislodged and carried over into the suction line of the pump. The linings and piston packing were soon worn, causing a decided increase of speed, especially on small deliveries. It was also noticed that the erratic action of the piston had ceased, but the other piston developed a bad knock at the crank end.

While the erratic motion of No. 1 piston was about mid-stroke as it receded from the head end, it was also noticed that the other piston was always at the extreme crank-end of its stroke. This was the position in which No. 2 piston developed its knock after wearing of the water-cylinder linings and led to the belief that No. 2 piston had a broken ring.

Examination disclosed that the ring had been put on in such a manner that its ends came directly over the exhaust port at the crank end. This interfered with the compression and permitted the piston to strike the end of the cylinder. It had also, on the former occasion, allowed sufficient leakage from the steam chest to the exhaust to cause the other piston to stop and reverse its direction slightly until lowering of the water pressure caused the governor to admit sufficient steam to overcome this leakage and restore normal motion to the piston. Turning the ring a few degrees on the piston remedied both the erratic motion in one piston and knock in the other.

San Francisco, Calif. WILLIAM E. SOREL.

Capacitor Installation Eliminates Overload on Turbine-Generator

THE Wyandotte Worsted Company of Pittsfield, Mass., generates its own power with a 500-kw., 3-phase, 230-volt turbine generator having a full-load current rating of 1,500 amp. The plant load was running from approximately 400 to 450 kw. at a power factor varying between 65 and 70 per cent, therefore the peak current was approximately 1,700 amp., considerably over the full-load rating of the turbine generator. To correct this

condition the company installed a 240-kva., 4,000-volt capacitor.

The load current was reduced from 1,700 to 1,300 amp., while the power factor was increased from 67 to 88 per cent. As a result of voltage improvement conditions on the exciter were also improved and about 75 hp. in motor load can now be added without overloading the turbine-generator.

Schenectady, N. Y. F. A. STORTZ, JR.
General Electric Co.

CURRENT COMMENT

Paint Versus Bubbles

REFERRING to the comment of A. J. Lubeley in your July number, the Dampney Company boiling demonstration sets were designed to make steaming action visible, and for no other purpose. Previous experiments using water tubes had indicated a variation in the character of steam release. The possible interest of direct observation suggested the "inside out" construction.

It is not claimed that the demonstration shows increase in steaming rate and efficiency. The boiler set shows only those differences in steaming characteristics which are visible and self-evident.

It *is* stated without qualification that in boiling water on flat plates, or from vertical or horizontal tubes, a coating of *Apexior* applied to bare evaporating surfaces completely changes the character of bubble release, which is a visible evidence of heat flow.

Steam bubbles from a coated surface are small and rapidly evolved. The number is infinitely increased. Distribution is almost entirely uniform. All surfaces to which heat is applied make steam. Generating areas are "alive."

Under stabilized operation, performance of a bare surface is exactly opposite. Bubbles are large and slowly evolved from a few scattered points. There is no uniformity in distribution and 60 per cent of the generating area is "dead." Uniform distribution of a much greater number of vaporization nuclei means a uniformly active generating surface with a tendency toward more rapid circulation and improved convection. Any *direct* beneficial effect on the rate of heat transfer, per unit of time, area and temperature difference, remains to be proved.

After ten years of experience with preservative coatings in boiler tubes and applied to the exterior of diesel cylinder liners, it is agreed in the power field that no heat retardation has been indicated. In main generating and water-wall tubes, under the higher range of operating pressures at Edgar, Deepwater, N. J., Gilbert, River Rouge, Lockland, San Antonio and Kansas City, as well as elsewhere under lower pressures, no evidence of overheating due to specially coated metal has been encountered.

In the operation of all sets, attention is directed to the starting-up performance of the bare-tube unit. Careful examination of what takes place will lead to an interesting conclusion. The initial activity is a "top boiling" from heat concentration in the tube at the upper level. Apparently heat flows upward in the metal wall more readily than into the water when the surface is bare.

The opposite is true of the coated unit, heat being given up more freely over the whole water contact area and at a lower temperature differential. The whole body of water comes uniformly to the boiling point. The same lag in a complete boiler would assist equalization of expansion stresses.

In starting up, cold or warm, the period before complete stabilization will show some evaporation in favor of the bare tube. Sometimes a little carry-over adds to the difference.

Upon checking both units from a running start, as in regular boiler testing, with temperature, heat flow and operation, stabilized, extended evaporation tests with automatic feed for maintenance of water levels show an average around 1½ per cent in favor of the coated unit.

We do not believe, however, that any quantitative result of a "kitchen experiment" should be considered valid except as an indicator that encourages further investigation.

Hyde Park, Mass. C. J. HUNTER
Vice-president, The Dampney Company of America

Reducing Valve Noise

WE WOULD like to add a practical comment to those made on page 409 of the July number of *Power* discussing the elimination of reducing valve noise. The correct solution, in our opinion, is the installation of a device such as the Boylston sound diffractor, a stationary assembly inserted in the expanding section connecting the reducing valve to the low-pressure line. More than 200 of these devices are in successful operation throughout the country.

Chicago, Ill. JOHN BOYLSTON
President Boylston Steam Specialty Co.

Lubrication Costs Increase With Small Diesels

J. H. BENDER in the August *Power* has ably discussed Mr. Schaefer's proposal (*Power*, May, 1934) for a battery of 64 high-speed diesels of 100-hp. rating. Mr. Bender has not, however, told the whole story. He has not discussed lubrication costs. When lubricating oil costs are considered, Mr. Bender's penalty of $22,700 per year for using 100 small diesels is more than doubled.

Recent published information on lubricating oil costs for diesel plants in Wisconsin for 1933 discloses large differences in economy between large and small units. Units around 1,000 hp. show 900 kw.-hr. per gal. whereas units around 100 hp. obtained only 250 kw.-hr. per gallon of lubricating oil.

Assuming equal generator efficiencies of 85%, (the large generators would be more efficient if they operated around 1,800 r.p.m., but this is not possible as the larger diesels must run slower), and Mr. Bender's figure of 21,900,000 b.hp.-hr. annual output, with lubricating oil at 60 cents per gallon in both cases, the cost of lubricating oil will be $9,300 per year for the large units and $33,400 per year for the small units, giving a net penalty of $24,100 per year against the small-unit plant.

Mr. Schaefer has undoubtedly in mind plants located at oil wells, but even then the refinery must process the lubricating oil before use.

I also read with interest your article, "Inertia Supercharging of a Semi-Diesel Engine," by A. H. Zerban, which appeared on page 453 of the August *Power*.

I hate to be one to "throw cold water," but this effect has misled a number of investigators who sought to "lift themselves by their own bootstraps" in the matter of supercharging. The pressure rise above atmosphere re-

sults of course, when the rapidly moving column of air in the intake pipe is stopped suddenly by the closing of the air inlet valve. The velocity "head" of the flowing air is converted into pressure "head" and the engine is apparently "supercharged."

However, the air in the intake pipe had a velocity only because there had been a reduction in pressure below atmosphere immediately before. The fact that the pressure in the intake pipe was above atmosphere when the inlet valve opened is explained when one recalls that a definite time is required for the air to travel down the pipe. During the time that a pulse of air is traveling, the inlet valve may be closed, while a substantial rarefaction obtains just ahead of the closed valve.

A dynamometer engine test or a volumetric check of the breathing capacity of the engine will substantiate the fallacy of the scheme.

New York, N. Y. T. STARLING WINTERS

Lock Your Valves For Real Safety

THE methods of locking valves for safety discussed in the May and July issues of *Power* are of great interest. There are many cases of emergency, however, when it may be necessary for a responsible person to open or close a locked valve in a hurry. In such an emergency the delay caused by looking for the key might prove a disadvantage. Quick operation under these conditions can be secured by providing a breakable lock such as those commonly used on fire-protection equipment. These locks are easily broken by almost any metallic or other instrument.

Certain valves can be left in the open or closed position to insure the proper operation of power plant equipment under normal operating conditions. As a check on the position of these valves during other than periods of abnormal operation, or as an indicator that abnormal conditions have existed, the lead and wire seal has its advantages. This seal, commonly used by utility companies to seal meters, is easily broken.

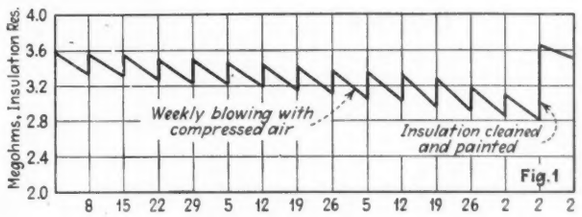
When, in the normal course of operation or of maintenance, it is necessary to protect men or equipment, danger tags should be used. All men employed in the plant should be thoroughly familiar with the procedure of using such tags. It is always advisable to delegate the responsibility of the placing or removing these tags to someone in a supervisory position. However, where there is danger of tampering, or where extreme hazards exist, locking the valves or controls becomes a necessity if maximum protection is to be secured.

Waynesboro, Va. S. H. COLEMAN

Factors that Influence Insulation Resistance

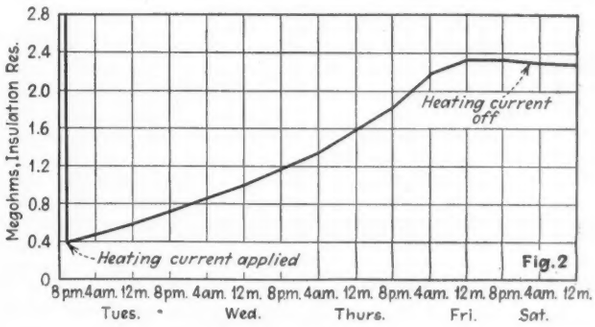
I HAVE been very much interested in the several discussions in *Power* on insulation resistance and wish to add my comments: Insulation resistance may be divided into two components, both of which must be kept above a minimum point for safe operation. These are volumetric or internal resistance, and surface or external resistance. The internal resistance is lowered by absorption of oil or moisture, which may be prevented by protective coatings of insulating varnish. External resistance depends upon cleanliness of the insulation surface. Periodic cleaning with compressed air and maintaining the surface hard and smooth with insulating varnish will keep the resistance value high by preventing dust from ventilating air collecting on its surface. Accumulation of metallic dust may easily lead to a flashover between conductors or to ground and serious damage to equipment. Often a low insulation-resistance test reading may be traced to a dust path to ground from an exposed conductor. After the machine is blown out with compressed air the proper resistance may again be obtained.

Insulation resistance tests include determining the condition of insulation before and after drying out moisture, checking results of repairs before high-voltage tests and acceptance of new equipment, etc. The curve, Fig. 1, shows the insulation resistance of a 300-hp.



2,300-volt, wound-rotor motor. Practice in this plant was to blow the motor out with air each week and paint the insulation surface, exposed to oil and moisture, each year.

The results of these operations are plainly shown on the curve. Fig. 2 shows a curve on a 100-hp. squirrel-cage motor that was flooded. The curve shows the

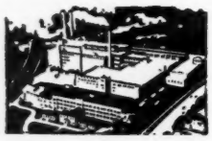


effect of the moisture and the drying-out process. Low-voltage direct current was applied to the stator winding, and readings were taken every eight hours for four days until the rise in insulation resistance reached a value considered safe. The insulation was then given a coat of insulating varnish, and the machine is now operating satisfactorily.

An approximate rule for minimum safe resistance of insulation is that it shall not be less than one megohm per 1,000 rated volts. One megohm is usually considered the danger line for low-tension rotating and industrial equipment. High-tension machines and cable work will generally have a resistance of over 100 megohms. The value of insulation testing is greatly increased if readings are taken at periodic intervals, say every two or three months, and recorded graphically. In this manner a sudden decrease in resistance will be apparent and the cause may be determined and corrected before failure of the machine.

Boston, Mass. HARRY M. SPRING, JR.

READERS' PROBLEMS



QUESTIONS for Our Readers

Fuse Studs Heat Excessively

QUESTION 1

ON OUR *switchboard the studs of 600-amp. renewable fuses in some of the three-phase circuits heat excessively. On three occasions fuses have blown from this cause. The studs have bene carefully aligned with the fuse terminals, but this did not correct the trouble even when clamps were used to hold the clips tightly to the fuse terminals. The maximum load on any of the fuses is about 400 amp. and the voltage between phases is 220. Can some reader of* POWER *give me some help with this problem?*

—J. H. P.

New Diesel or Supercharger

QUESTION 2

WE HAVE *two 500-hp., 4-cycle diesels in a plant 5,000 ft. above sea level. Recently load has increased and we would like to increase plant peak capacity to about 1,200 hp. Is it preferable to add another engine or will superchargers solve our problem more economically?* —W. R. O.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Freon

IN THE *July number of* POWER *there was an article on the refrigerating plant in the new Post Office Building, Washington, D. C., in which Freon is used as the refrigerant. However, nothing is given in the article about the nature and properties of Freon. I should like to know what Freon is. What are its characteristics and properties?*

L. W. C.

"Freon" is the trade name for the chemical dichlorodifluromethane which was first suggested as a refrigerant about 1907. It has not been used generally until recently. It is a non-combustible, non-explosive and at normal temperature a non-toxic refrigerant. In the presence of flame and hot surfaces (1,022 deg. F.) dichlorodifuromethane is decomposed, forming toxic products which are exceedingly irritating and, therefore, give adequate warning. However, in the presence of open coil hot resistance wire, even when cherry red, practically no toxic decomposition products are formed during ½ hr. exposure.

The theoretical displacement per ton of refrigeration when using Freon is 5.83 cu. ft. per minute, and 3.92 lb. of the refrigerant must circulate per minute. The horsepower required per ton is but little more than when using ammonia.

Tables showing thermal properties of Freon are available in such books as the Refrigerating Data Book of the American Society of Refrigerating Engineers. These tables show, for example, that at 5 deg. F. the absolute pressure is 26.5 lb. per sq. in., volume of vapor is 1.49 cu. ft. per lb., heat of liquid 9.3 B.t.u., latent heat 69.5 B.t.u. At 86 deg. F. absolute pressure is 107.9 lb., specific volume 0.389 cu. ft., heat of liquid 27.7 B.t.u., and latent heat 59.7. Thermal properties are on 40 deg. base.

What is a Stone?

WHAT *amount of power is equivalent to a "stone"? I have run across some old water-power rights which are rated in "stones" and am wondering what the equivalent is in horsepower.* —C. R. E.

As given in the American Civil Engineer's Handbook, 1930 edition, pages 1370 and 1371, published by John Wiley & Son, 440 Fourth Ave., New York City, the stone is the equivalent of the power required to drive a run of millstone for grinding grain. This unit was used quite commonly in the early days, but, unfortunately, its value varies considerably. A run of stone in a common country grist mill requires from 12 to 15 hp. In the early days, when the stones were smaller, the amount of auxiliary machinery was not extensive and the power required to drive the stone was somewhat less than the figure given. A run of stone in a second-class merchant mill, yielding 50 to 60 barrels of flour per day, will require 20 to 25 hp. to drive it. In a first-class merchant mill, yielding 80 to 100 barrels of flour per day, a run of stone will require 30 to 40 hp. It may be assumed that the value generally used is 12 to 15 hp.

STEAM-ENGINE EXHAUST WILL DEPOSIT SOME OIL IN HEATING SYSTEM

ANSWERS to July Question 1

THE QUESTION

I AM *considering the installation of a steam engine, the exhaust to be used in our steam heating system. I have been told that oil will be carried over with the exhaust steam and deposited in the radiators. The oil decreases the heating capacity of the radiators and may make them unable to heat the building satisfactorily.*

Is this a common difficulty or can it be avoided by proper operation and installation? How can oil in the heating system be removed? E. R. H.

No Way to Eliminate Oil

THERE is no way to eliminate from the exhaust of a steam engine oil which has been used for valve and cylinder lubrication without external equipment. The amount, however, can be materially reduced by the use of an atomizer in the high-pressure steam line instead of the usual hydrostatic lubricator.

The oil atomizer makes for economical operation because of its greater efficiency. Steam, in passing through the "spoon" of the atomizer, which is located above the throttle valve and extends about half the distance through the pipe, forces the oil through fine nozzles and thus creates a mist of cylinder oil.

Nevertheless, oil in even this form is carried out with the exhaust steam and presents a problem that must be reckoned with. If an engine is working against a vacuum (instead of a back-pressure, as in the case stated by E. R. H.) this oil forms a film on the condenser tubes, and as it acts as a heat insulator, its effect on heat transfer, vacuum, water rate and economical operation can be readily appreciated. If the condensate is used as boiler feedwater, the oil it contains may cause pockets on the boiler tubes, which is not only uneconomical but also dangerous.

The only way to remove this oil efficiently is by the installation of an oil separator in the exhaust line. These separators extract the oil by sharply redirecting the steam flow by means of baffles, etc., and are most effective.

Kingsport, Tenn. B. E. LINGARD

Use Soda-Ash to Clean Out Oil

IF YOUR steam engine uses saturated steam at less than 250 lb. pressure you will do well to use no cylinder oil at all and oil carry-over trouble will never occur. I maintain there is enough moisture in the steam to lubricate adequately the pistons and valves. This has been my practical experience over a period of 14 years at sea and on land, including a 6-mo. test on a large Atlantic liner during which no cylinder oil was used.

Once oil is in the heating system, it is quite difficult to remove it. The best method is to circulate a strong and hot solution of soda-ash through the heating system while it is not in use. This will require the temporary installation of tank and pump.

Passaic, N. J. M. BELL

Install Oil Separator

OPERATION of engines running into thousands of horsepower, with practically the entire exhaust used in an extensive heating system containing radiating surfaces of all types, reveals no trouble in the heating system itself if certain precautions are observed.

All that is necessary is to use a suitable cylinder oil, one that does not vaporize excessively under the steam conditions existing. Likewise, all the steam exhaust must be put through a baffle separator of proper design before it is used in a heating system. Practically all the liquefied oil, even if finely subdivided, together with the moisture in the exhaust steam, will be caught in such a separator. Suitable traps should be provided for continuously eliminating the oil and condensate. Their discharge should be run to waste.

Once the oil is in a heating system, the only practical way to eliminate it is to gradually let it be scrubbed away by clean condensate over a long period of time.

It should be pointed out that while no trouble will be experienced in the heating system, certain serious results may follow from the small trace that gets by a separator, together with the vaporized oil, in boilers and economizers. In high-pressure, high-capacity boilers tube burn-outs will invariably follow. For such boilers the condensate must be given chemical treatment for the removal of these last traces.

Rochester, N. Y. L. J. SFORZINI

If Steam Is Saturated, Why Use Lubrication?

IF E. R. H. intends to use steam superheated more than 20 deg., any one of several good exhaust steam separators now on the market, installed in the exhaust line between the engine and the heating coils, will remove the oil to a sufficient extent so that no trouble will be experienced from oil deposited in the radiators, providing the proper oil for the service is used.

We use 6 gal. of cylinder oil per week, in twelve steam cylinders, the exhaust steam going to paper machine dryers and (heating) coils, without experiencing any difficulty as far as heat transfer is concerned, but we did have to install stocking filters in the condensate return line to prevent some oil from getting back into the boilers.

However, if E. R. H. plans to use saturated steam, or steam with less than 20-deg. superheat, why not eliminate the whole oil problem by eliminating oil lubrication in his steam cylinders entirely?

Thirty years ago, I served on a ship driven by four triple-expansion steam engines which developed 18,000 hp., and no steam cylinder on this ship ever received any oil lubrication. Of course we used saturated steam at 200-lb. pressure, and all the cylinders were vertical, so that the friction caused by the weight of the piston did not need to be taken into account. In thirty years of land practice, I have used this experience in weaning many corliss and slide-valve engines operated on saturated steam away from oil without trouble.

I am now operating two slow-speed horizontal engines, using steam superheated 100 deg. without cylinder lubrication. They squeak occasionally, but after two years of operation without oil, the cylinder walls are burnished and without a scratch.

It has always been my theory that very few pistons seized, or cylinder walls were scored that could not be traced to dirty steam or particles of scale from the steam lines, etc. Oil will not remedy such conditions.

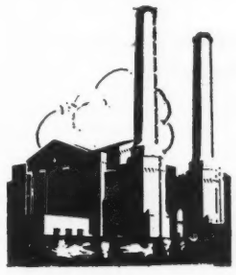
Escanaba, Mich. A. H. W.

Oil-Clogged Return Traps

THE oil from steam engine exhaust should be removed before entering the heating system, or the following trouble may be expected:

The oil will be carried over and deposited in the radiators. In gasket made-up radiators, some of it will seep through the gaskets, causing unsightly radiators and stained floors. In a vacuum system, the radiator traps and other low-pressure traps soon become filled, making it impossible to maintain a proper vacuum.

If the condensate is returned to the boiler, a considerable amount of oil will be carried back and deposited in the bolier shell and tubes, reducing the efficiency of



the boiler and necessitating numerous shutdowns to remove the oil deposit.

A few years ago, I was troubled with just such a condition, and our method of eliminating the trouble may be helpful to E. R. H.

We installed an oil separator of ample size in the exhaust line a considerable distance from the point of exhaust. An oil trap is connected to the oil separator through which all oil may be reclaimed if found profitable. After the installation of the oil separator, we found that some oil was still getting into our radiators and boilers.

Normally, we have to supply an additional 50 to 70 per cent live or make-up steam to our exhaust to supply our heating system. This make-up steam was going through the oil separator with the exhaust. The resultant velocity was so high that some oil was being carried through the oil separator. We then transferred the make-up ahead of the separator, thus eliminating all but a slight amount of oil in the steam to our heating system.

Spivak, Colo. CHAS. O'HARE

Use Lubricant With Little Compounding

THERE is, of course, some probability of oil being carried by the exhaust steam into the heating system, but this can be almost entirely eliminated by the use of an efficient oil separator in the exhaust line. The savings that can be made by use of exhaust steam for heating in contrast with live steam are large enough to warrant purchase of an oil separator which will remove practically all the oil.

Proper choice of oil is important. Only enough compounding should be used to maintain a film on the cylinder walls. The more highly compounded an oil is the more difficult it is to remove it. The compound causes the oil to form an emulsion which is more difficult to separate than atomized oil in suspension in the steam. A high-grade mineral oil with a small amount of high-quality compounding can be removed very effectively.

Corvallis, Ore. WALLACE H. MARTIN

Oil in Heating System Stops Corrosion

IT IS true that a certain amount of oil is carried in the exhaust steam from an engine and that a coating of oil on heating surfaces greatly retards the rate of heat transfer. It is, however, inconceivable that sufficient quantities of oil will be carried over into the heating system to be objectionable unless an excess of oil is used in the engine cylinders.

In my experience with exhaust steam heating systems it has never been found necessary to employ any means of oil removal from the exhaust steam or heating surfaces. We have used the exhaust from engines up to 700 hp. in the heating systems of large industrial buildings for over twenty years. Initial steam was saturated at 100 lb. and pressures of 5 to 7 lb. were maintained in the heating system. The engines from which the exhaust was utilized were of various types, including slide-valve, piston-valve throttle-governed and automatic cutoff-valve engines. During the past few years a number of these old buildings have been replaced with more modern structures and upon dismantling the exhaust steam heating systems no objectionable cases of oil deposit were noted.

Rather than considering oil carry-over detrimental, we have always believed it to be of benefit inasmuch as the wet exhaust steam has a tendency to cut or groove the pipe lines where the water sweeps along the bottom and to corrode the pipe at connections. Oil carry over provides sufficient coating practically to eliminate this damage to the piping system.

It has been my experience that on long live-steam transmission lines, even when well trapped, that serious erosion of the pipe takes place due to the wetness of the steam. To overcome this condition lubricators were installed in all steam lines of any length and cylinder oil was periodically fed into the line. Lines which formerly gave considerable trouble due to leaks at both screwed and flanged joints in addition to pipe erosion, became trouble-free after receiving several injections of oil.

From the foregoing experiences, I draw the following conclusion: Unless extreme quantities of oil are present in the exhaust, no means of oil removal is needed, as the normal amount of oil present is desirable to counteract the wetness of the exhaust steam, thus preventing damage to the piping. However, if excessive oil should be found in the exhaust that requires removal, there are numerous oil separators on the market that would be satisfactory for these requirements.

Pottsville, Pa. C. T. REILLY.

A.-C. GENERATORS CAN BE PARALLELED AS SUGGESTED IN THE QUESTION

ANSWERS to July Question 2

THE QUESTION

OUR motor-driven exciter failed while serving four generators operating in parallel in a hydro-electric plant, and the plant went dead. The generators probably ran at different no-load speeds, but to restore service as quickly as possible, the circuit breaker was opened on the motor-driven exciter and a waterwheel-driven exciter was connected to the bus. The exciter was then started while the main generators were still connected to their bus. When the exciter voltage built up to about 75 per cent normal, the generators pulled into step and service was restored in about 2 min. from the time the trouble started. Have other POWER *readers had similar troubles and how did they handle them? Can the method I use to parallel the generators be generally applied in such emergencies? If there is a better method what practice should be followed?* —A. A. C.

Has Had a Similar Experience

I HAVE had an experience similar to A. A. C. when operating a power plant about 22 years ago. One evening we were operating a 3,750-kva. turbo-generator unit in parallel with a 1,000-kva. corliss-engine driven unit. Both of these generators were excited from an exciter bus supplied by a turbo-unit. The spring on the centrifugal safety device broke on the exciter turbine and before it was noticed, vibration of the machine caused the emergency overspeed device to trip. It is necessary in such a case to close the steam valve and reset the trip device before the valve can be reopened to put the machine in service. As luck would have it, the main steam valve had become jammed and a bar had to be used to close the valve in order to set the emergency device. In the meantime, both generators had automatically throttled through their governors, but were still connected to the bus. By the time we were able to get steam to the turbo-exciter unit the direct-current voltage had dropped to virtually zero. When exciter voltage built up again, bus voltage also gradually came up. Although there was a slight hunting between the machines, both gradually settled down and continued to operate in synchronism.

Incidentally, the corliss engine-driven unit had quite a record for hunting even under the best of conditions, so that it was a surprise to find that the machines operated satisfactorily in parallel after a very small amount of hunting had taken place. In view of this experience, it is my opinion that this method could be used to parallel generators, although it would hardly be recommended except in an emergency. Should hunting become prolonged or evidence is seen that it is being aggravated, the smaller unit may be discontinued from the bus at the proper time. Some feeder switches may be opened so that the remaining unit can successfully carry the load. The second machine may then be again synchronized to the bus in the usual way.

New York City. EUSTACE C. SOARES
Treasurer,
The R. B. Engineering Corp.

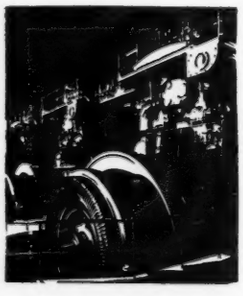
Recommends Opening Feeder Switches

WE HAVE used the method described by A. A. C. with satisfactory results in an emergency, bringing into synchronism a 1,500-kw. and a 2,000-kw. turbo-generator after failure of a voltage regulator. This method is about the fastest that may be used in restoring service. As a precaution, all feeders should be disconnected from the main bus before applying excitation until normal voltage has been restored, as any motor connected to the system while the units are being brought into step may be damaged.

Central Delicias, Cuba. E. MOLINET
Electrical Engineer,
The Cuban-American Sugar Co.

Method Used With Utility Diesels

A. A. C. should have no trouble paralleling his generators as outlined in the question, providing the units do not represent the larger part of the capacity on the system. If the units are large it may be difficult to get them to pull into step without large voltage and frequency surges. A plan similar to that described is used by a utility company. All of its stations are equipped with frequency alarms. When the frequency lowers a certain amount, alarms sound in all diesel stations. These units are started and brought up to near operating speed when the circuit breakers are closed, connecting the units to the system. The exciter field switch is then closed and voltage built up and units pull into step.



These diesel units are small—of 400 to 700-kw. capacity. They are not large enough to disturb the voltage or frequency of the system which is supplied by several large steam stations with diesels for standby and peak-load service.

Walthill, Neb. WM. W. DINGWALL

Relates Experience

I HAVE seen a 33,000-kw. plant pull into step on a line at normal voltage when being tested for trouble during a storm. This plant paralleled with another station on the system that did not go off when the trouble occurred. This, however, in my opinion, is a coincidence and cannot be expected to work successfully every time. I have also seen large units pull out of step because of improper excitation, but I have never seen one pull back into step again and pick up load. They had to be disconnected from the system and resynchronized. When these machines pulled out of step, they caused other plants to surge and synchronous motors and converters to start hunting.

Roosevelt, Ariz. W. P. GIBSON

Care Should Be Exercised When Paralleling Machines

FROM A. A. C.'s question I assume that each main generator is governed and that their speed are approximately correct; that each generator has a rheostat set to give correct excitation; that the generators are of similar size, and each will build up promptly. This being true his method of starting is all right, but it is unwise to attempt paralleling machines in that way if there is any probabiliy of their being on a live line. In such a case the induced voltage in the field coils will probably equal the main generator voltage. This is likely to wreck the field insulation or burn anyone attempting to adjust sparking collector-ring brushes thinking he is handling exciter voltage.

Leesville, S. C. F. E. BRODIE
Brodie Light & Power Co.

Suggests Using the Conventional Methods

ALTHOUGH the method used by A. A. C. worked to advantage in the instance cited, I do not believe it could be generally applied in such emergencies because of the diverse factors entering into paralleling and parallel operation of generators. A better policy when putting the generators back into operation after such outages would be to follow the usual method of paralleling, even though the duration of the outage must be longer. This would eliminate chances of development of damaging conditions. It is the most logical plan unless knowledge of changes in speed, frequency and voltage relations is such as assure that correct paralleling conditions will not be adversely affected by sudden removal of the load.

St. Marys, Ohio. J. L. YOUNG

SMOKE ABATEMENT PROBLEMS

By **WILLIAM G. CHRISTY***
Smoke Abatement Engineer,
Hudson County, N. J.

IN MOST hand-fired plants, two essential elements of complete combustion are lacking—time and turbulence. Combustion space is insufficient and hence there is not enough time for proper combustion of the volatiles to take place. If the boilers are not too heavily overloaded, smoke can often be eliminated or greatly reduced by the installation of steam-air jets. Yet some plants equipped with jets continue to smoke. There is still too much dependence on the human element.

Many plants have boilers set very low, that is, with furnace volumes which are much too small. If such boilers carry heavy loads, steam-air jets will not give a good smoke performance. About the only thing to do with such a plant is to install stokers or oil burners, or, better still, put in new boilers.

Hundreds, perhaps thousands, of underfeed stokers are not operated properly: Air adjustment is not watched and changed with coal feed. Slice bars, hoes and other firing tools are used much too frequently. In banking or when picking up a heavy load, some firemen even shovel coal on top of the retort. The habits of years of hand-firing are hard to break. A great deal too much smoke is made in cleaning fires and most of it is unnecessary.

Don't Forget Fly Ash

Too little attention is paid to the discharge of fly-ash from the stacks of stoker-fired plants. The amount varies greatly with size and characteristics of the coal, design of stoker, type of boiler, breeching and chimney, and with the operation. A sized coal, especially on small stokers, is preferable. This fly-ash presents a problem which smoke department executives must face now—particularly with installations in residential districts. I believe that a dust collector, flue gas scrubber, or similar device ought to be required with a stoker. The fly-ash condition is often aggravated because far too much air is supplied.

Chain grate and traveling grate stokers are well suited for burning bituminous coal, especially the higher ash coals of the West. Many of the older natural-draft chain-grate installations pollute our atmosphere. Seldom do they violate the average ordinance, but they often emit No. 1 or No. 2 smoke for hours. Turbulence, supplied by introduction of overfire air at high velocity, will usually clear up the stack. The latest models of forced-draft chain- or traveling-grate stokers, with zones for controlling air, give excellent results. Pulverized coal installations sometimes make excessive smoke. On some of the older jobs, this may be due to insufficient furnace volume. In time, the mills get worn and the coal is too coarse, resulting in smoke violations. The trouble may be due to improper adjustment of air and coal feed. Another common source of trouble is starting up a cold boiler too quickly. Load demands should be anticipated as much as possible.

Oil burners are also the cause of many headaches for the smoke inspector. This is especially true in heating plants. The tips carbon up in many types of burners. If they are not cleaned promptly, the burner gets out of adjustment with consequent dense smoke. Sometimes trouble is caused by the owner trying to use a heavier grade of oil than that for which the equipment is designed. Oil smoke is more objectionable than coal smoke, as it carries a greasy soot.

Maintain Equipment

Service and maintenance of fuel-burning equipment can not be repeated too often or stressed too much. They are so frequently overlooked. Every item and part of fuel-burning equipment should have periodic inspection. Cleaning, repair and replacement should be attended to immediately. This applies to fuel pumps, strainers, heaters, valves, blowers, burners, motors, engines, gears, tuyeres, dead and dump plates, coal and ash conveyors, grinding mills, control apparatus, refractories, boiler heating surfaces, breechings, stacks and instruments.

There is altogether too much smoke from heating plants. One of the chief reasons is that heating equipment gets too little attention. Many owners feel that when they put in stokers or oil burners, their heating troubles are over. Most oil burners and stokers in small heating plants are not maintained properly. They should be inspected and serviced at least once a month by a competent mechanic.

Hand firing of bituminous coal in small heating boilers is wasteful and usually results in plenty of smoke. It is almost a hopeless task to eliminate smoke from heating plants by trying to educate the thousands in any large city who fire these boilers and furnaces.

Every plant which burns a potentially smoky fuel should be equipped with smoke indicators. The best type of indicator is that which lights a red light and blows a Klaxon horn when any smoke is made.

Those of us engaged in smoke work need a better method of measuring fly-ash. A visual determination by the Ringelmann Chart is quite unsatisfactory. We need a simple method of measuring fly-ash content and also a standard by which to measure it and define a violation.

In our discussion of smoke problems, we often give most of our attention to equipment and to fuel. While conditions must be right in the furnace to get complete combustion, the plants giving best smoke performance are those where everyone concerned with operation of those plants is smoke minded.

I have left to the last what I believe is the most important part of smoke regulation—permits for installation of new equipment. Without such regulation, new smokers may be added to the list every day. The ordinance and the regulations should apply to every fuel burning plant, including private residences. It is also a good idea to have the rules governing new equipment separate from the ordinance. When details of boilers, oil burners, stokers, chimneys, etc., are written into an ordinance, it is necessary to amend the ordinance when changes are desired. Experience and new technical developments often make changes necessary.

In approving application for permits to install equipment or devices, we should treat all alike. In other words, stick to the regulation, no matter who the applicant and what the circumstances. With this policy in effect, the department is respected and applicants soon realize they will get a square deal.

All rules and regulations should be concrete and definite. Try to cover every contingency and avoid any ambiguity. Estimates can then be made with minimum time and effort spent on interpretation of regulations. Manufacturers and contractors are assured that competitors must figure on the same basis. It also gives consulting engineers and architects concrete and definite knowledge for use in drawing plans and writing specifications.

Hudson County Regulations

Some of the high spots of the Hudson County regulations may be of interest. Hand firing of bituminous coal is not approved. Heating installations are approved for hand firing anthracite coal or coke. Stokers, oil burners or powdered coal are required for all new power boilers. Definite boiler furnace heights for stokers are tabulated for various types and sizes of boilers.

For pulverized coal, heat liberation in refractory furnaces is limited to 20,000 B.t.u. per cu.ft. per hr. Some provision for collecting fly-ash is required. Maximum heat liberation in heating boilers burning oil is 25,000 B.t.u. and in power boilers with refractory furnaces is 30,000. Proper furnace design is most important for oil burning but this is difficult to specify in rules.

Smoke indicators, making it possible for the operator to observe smoke conditions at all times, are required for new boiler plants. Fixed ventilation, to assure air for combustion, is a requisite for all fuel burning plants.

I believe the average smoke ordinance is too lenient. The Hudson County ordinance makes 2 minutes of No. 3 smoke in a period of 15 minutes, a violation with no allowance for starting or cleaning fires.

*Abstract of a paper delivered at Annual Meeting of Smoke Prevention Ass'n., Buffalo, N. Y., June 20.

OPERATING AND MAINTAINING DIESEL ENGINES

By GEOFFREY PORTER*
Borough Electrical Engineer,
Worthing, England

TO THE operating engineer accustomed to steam technique the diesel appears complicated and unreliable. But even short experience proves that a well-designed and intelligently operated diesel lacks nothing in reliability and ease of working. Diesels have proved themselves no less reliable than our former steam plant, while being infinitely more economical in service. Operation has been found simpler.

To insure successful results with diesel engines the purchasing engineer should possess a reasonably sound understanding of the internal-combustion engine heat cycle and the details of engine construction and plant layout. Right selection is the first essential; first cost is an uncertain criterion that leads only to disaster. The method of operating has very close relation to the cost of maintenance.

One very important difference between diesel and steam engines should be noted at the outset. In the diesel the maximum pressure on the piston occurs during starting. A 12-in. piston loaded with starting air at 700 lb. per sq.in. bears a load of 35 tons. This whole load is transmitted to the piston pin or crosshead and thence via the connecting rod and bottom-end bearing to the main crankshaft bearings. The normal connecting rod/crank ratio varies from 5 to 5.5 to 1. Now, unless the fit of the connecting-rod bearings is good (a clearance of about 0.004 in. would be required in a 12-in. cylinder), and care is taken to insure a sufficient supply of lubricating oil and maintenance of a sufficient oil film in the top and bottom connecting-rod ends and main crankshaft bearings at the moment of starting, these bearings will be damaged, if not destroyed, in a comparatively short time. Means are provided for initial flooding of the bearings before starting the engine, and it is essential that this flooding never be neglected, even when circumstances call for a quick start.

Other defects, mainly those in air and fuel valves, may cause trouble at starting, but at the moment it is assumed that all parts are in good working order. Occasionally, the fuel by-pass valve fails to operate. This valve is fitted to the cylinders used for compressed-air starting when air alone may be used, and should its working parts become gummy, the engine may either fail to start or may start abnormally. The cause is most puzzling to an attendant until he "knows" the engine.

Also, when starting up, be sure the starting-air valve is free. Sometimes this valve (or valves in a multi-cylinder engine) sticks, and the resulting noise is alarming and may be attended by damage. The attendant will quickly learn a short routine to insure that valves are at least operating properly. The main air-starting valve usually gives no trouble, and when it fails to function usually has grit between valve stem and guide.

To revert to lubrication: a few minutes' running with insufficient lubrication may have widespread consequences. The piston pin is probably the most difficult part with regard to lubrication. It carries heavy loads, has a small angle of swing, and if wear has occurred in the bushing, it may not retain a sufficient supply of oil. The pin then runs hot, the heat expands the bracket by which it is attached to the piston, the piston, locally heated, distorts, and since clearances are only 0.008 to 0.010 in., usually seizes. Both liner and piston are damaged; in fact all running parts may be affected. Piston seizure may occur during normal engine running, but usually a characteristic knock gives sufficient warning.

Such troubles are rare, and if they occur frequently, are usually the fault of careless fitting or careless attendants. It is the writer's opinion that a primary cause of subsequent trouble is carelessness, especially at starting. The remedy is a simple, common-sense routine, and an operator with common sense and intelligence. The writer prefers to train a promising man rather than try to convert an experienced steam engineer. It is almost impossible to persuade such a man that his previous experience is practically useless when applied to an internal combustion engine.

Starting Air Pressure

It is a sound rule to start a diesel with the least possible air pressure. Engines vary so that no hard and fast rule can be laid down, but if the engine is in good repair, it should start without shock with about 800 lb. A skilled man may be able to start with 500 lb. or even less. In course of time, starting may become sluggish, even to the extent of reducing the air-storage pressure below an essential minimum. When sluggish starting occurs a second or third time, an examination should be made to find the cause. When the engine fails to fire, fuel oil is being injected into the non-starting cylinder or cylinders and collected on the piston head, creating the possibility of excess fuel oil being fired at any moment with a resulting excessive pressure beyond the capacity of engine parts to withstand.

It is essential to study carefully the effect of air injection pressure. No two engines are quite alike in their response to the velocity with which fuel is injected into the cylinder and to the volume of the injection air, which, it must be remembered, is in addition to the volume of combustion air, thus has a decided cooling effect upon cylinder contents. Too low an injection pressure causes smoke and overloading. The maker's instructions upon this point must be carefully followed, and adjustments made according to load by the controls provided. The influence of air injection pressure upon fuel economy is considerable. This is affected, often seriously, by the arrangement of fuel pumps and delivery piping and also by the arrangement of injection air piping. In the latter there may be an appreciable difference of air pressure between the cylinder nearest the air compressor delivery and that furthest away. The length of fuel piping is also important in a multi-cylinder engine. For this reason the writer prefers the arrangement by which a fuel pump is fitted to each cylinder, all delivery pipes being approximately equal in length.

Difficult Starting

Causes of bad starting are: defective and choked air and fuel pipe connections, too high and too low air starting and injection air pressures, stuck or worn piston rings, both in the main engine and the air compressor, excessive liner wear, water leakage to engine cylinders from cooling water jackets and passages, defective air and exhaust valves, carbon on fuel valve seats, and neglect to open the delivery cock on the fuel-oil tank.

A lazy method of shutting down is likely to lead to unnecessary maintenance work. An easy way that appeals to some is to shut off the air and allow the engine to slow down with the fuel pumps drawing fuel until the engine comes to rest. At the next start, every cylinder contains a considerable quantity of fuel oil, which when fired by compression and added to the incoming fuel burned, produces a heavy explosion. This may blow off the fuel valve and casing. If supervision and operation are right, such things do not occur, and the engine builder is not responsible. Heavy maintenance and repair work on diesels is the result of cumulative unintelligent handling.

Routine inspection is essential. Most of it can be done by the operator. It is all-important to maintain all valves in good order. Air-inlet valves seldom require attention when the combustion air is free from grit. Introduction of an air filter to insure clean air is sometimes necessary. Fuel valves need regular attention. Not only must the coned needle and its seat be kept in perfect condition, but care must be taken to keep the

*Abstract of an article in "The Power Engineer" (England), July, 1934.

labyrinth perfectly clean in order to avoid restriction. Ordinarily fuel valves should be cleaned at least twice a week. Fuel valves in bad condition lead to bad combustion, high mean temperatures in the cylinder and damaged exhaust valves and seats. In a 2-cycle engine, neglected fuel valves will cause an accumulation of carbon in the exhaust ports, with attendant trouble. Fuel valve grinding is simple, but requires care and intelligence.

Exhaust valves should be inspected every 200 engine hours when the valves and/or the seats are not cooled and have coned faces and seats. All marks on both faces should be ground out, using a little fine carborundum powder in oil. Adequately water-cooled and flat-seated exhaust valves will work for as long as 2,000 hours without attention. Fuel-oil centrifugal separators will also reduce exhaust valve maintenance. Much of the pitting is caused by small hard particles being pounded into the faces. Apart from this, bad combustion and the production of high temperatures at the wrong part of the combustion cycle leads to rapid destruction of exhaust valves.

The air compressor should also be examined periodically, for a compressor in bad condition is definitely dangerous. It is essential that the numerous small and light valves and springs be kept in first-class order. They must be maintained free from warping and must seat truly. If they are permitted to deteriorate, inter-stage leakage of air will result, the balance of the compressor will be upset, irregular temperatures built up. Low-pressure intercoolers and other small parts will eventually wear out by erosion. Their condition can be gaged by weighing them periodically; and by comparison with records it is easy to tell when renewal is imminent.

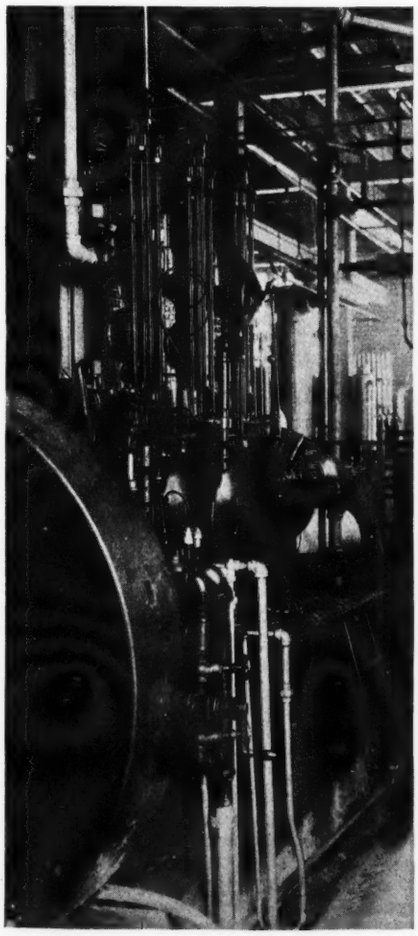
Most important and often least understood on an air compressor is its lubrication. The quantity of oil supplied to the air cylinders must be an absolute minimum. Notably, in the high-pressure cylinder where air is compressed to more than 1,000 lb., one drop of oil per minute, or even less, is plenty. The exceedingly high temperatures of the high-pressure stage carbonize any excess lubricant immediately.

Governor setting must be checked periodically to insure full control of fuel supply. Only a skilled fitter or engineer should be allowed to make the adjustments, and he should make it part of his work to see that all parts of the governor are free and in proper working order. He must be careful to see that the suction and delivery valves of the fuel pumps are in good condition, opening and closing correctly, and fuel admission to the cylinders properly timed.

The study of combustion is most readily carried out by means of the indicator diagram. It is a waste of time to take a series of cards showing the whole cycle. Unless such cards are noticeably bad, they are of little value. What is valuable is the "firing" card taken by hand operation of the indicator during a period of 20 deg. before and after fuel admission. Such cards are easily taken with a little practice. One type of firing line will of course not be best for all engines. The lines should however rise and fall smoothly before and after opening of the fuel valve, indicating combustion without shock and freedom from "after-burning." A slight pressure rise of 10 to 15 lb. during combustion leads to most economical results. It is common-sense to use as reference cards the indicator cards and their results obtained during the acceptance trials of the engine.

COMPLETELY DIESELIZED ICE PLANT

By FRANCIS A. WESTBROOK
Mechanical Engineer



One of the 90-hp. compressor driving diesels

HENRY Bolduc Ice Mfg. Co., Fitchburg, Mass., this year installed three diesels to supply all power and lighting needs. Operating economy has been extremely satisfactory. The plant is composed of two 3-cyl., 10x13-in., 90-hp., 300-r.p.m. Atlas-Imperial diesels each driving a 25-ton York ice machine and a generator. The first unit, installed in May, 1933, also drives an 18.7-kva. generator by multiple Dayton cog-belt drive. The other, installed in September, drives a 15-kw. generator, also by cog-belts.

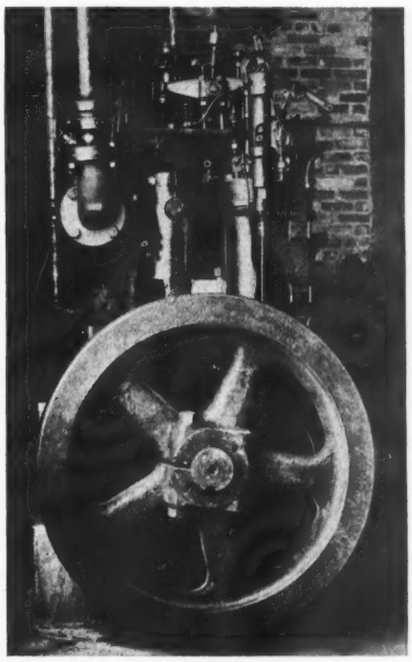
The third diesel is a 4-cyl., 6½x8½-in., 45-hp. unit used for generating power only, especially in winter when the ice machines are used only infrequently. It drives a 60-kva. generator by cog belts.

During the summer, the ice plant operates 24 hours a day. For that reason the first diesel was installed in May to permit careful testing. During an average 24-hr. period, fuel consumption was 115 gal. of No. 3 fuel oil, lubricating oil consumption 2 qt. Total oil cost was $5.44, with the unit carrying both the ice machine and generator. These results led the company to plan complete changeover to diesel.

The public service company was consulted, and after studying the log book and operating sheets decided it could not offer power at a competitive rate. The second and third units were then obtained, making the plant independent of outside power.

The load which the third diesel handles is somewhat varied. It includes two blowers, each driven by 3-hp. motor, a 4x4-in. York compressor driven by 7½-hp. motor, a scoring machine driven by 3-hp. motor, a stacker with a 1-hp. motor, two agitators each with a 5-hp. motor, a traveling crane with 1½-hp. motor, and the lights.

Starting air is furnished by a small Curtis 3⅜x3½-in. compressor driven by 3-hp. McCormick-Deering gasoline unit.



The 45-hp. generator-driving unit

THE ENGINEER'S BOOKSHELF

Power Plant Testing

POWER PLANT TESTING (4TH EDITION)—*By James A. Moyer, director of University Extension, Commonwealth of Massachusetts. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 614 pages, 6 x 9 in., 335 illustrations, 49 tables. 61 tables and Mollier chart on ammonia in appendix. Index. Cloth covers. Price $5.00.*

This is a rewriting and enlargement of this standard manual for testing steam-generating equipment, engines, turbines, pumps, refrigerating machinery, fans, fuels, lubricants, etc. Rewriting was made necessary by the increasing exactness of test methods and introduction of high steam pressures. This is a reference handbook on testing prime movers and other power plant equipment and only secondarily a text.

Gas Handbook

GAS ENGINEERS' HANDBOOK (1934)—*Prepared by Gas Engineers' Handbook Committee of the Pacific Coast Gas Assn. and reviewed by a special committee of the American Gas Association. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y. 1017 pages, 6 x 9 in. 467 tables. Cloth covers. 345 diagrams. Indexed. Price $7.50.*

Physical, chemical thermodynamic and other constants and formulas, tables and graphs essential in the work of the gas engineer are here combined in one ready reference book. Probably the best idea of this book, fourteen years in preparation, can be gained from a review of the sections. These are: Mathematical and Conversion Tables and Graphs; Properties of Elements, Common Substances, and Engineering Materials; Properties of Gases, Air, Steam and Water; Fuels and Combustion; Production of Gas (250 pages); Testing and Measurement; Transmission and Utilization; Utilization of Gas (120 pages).

This is a working handbook for the gas engineer, whether he deals with producer, blue, oil, water, coal or Siemen's gas, and no matter what his particular job. Even fundamental mathematics, pipe layouts and welding have their part. Gas engine data take only two pages.

Theory of Gases

KINETIC THEORY OF GASES (2ND EDITION)—*By Leonard B. Loeb, professor of physics, University of California. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y., 687 pages, 6 x 9 in. Cloth covers. Name and subject indexes. Six appendices. 85 diagrams and graphs. Price $6.*

This is a text and reference book combining classical deductions and recent experimental advances in convenient form. In this revision of the first edition, at least a third of the content has been rewritten, largely those sections having to do with molecular structure and its influence on molecular behavior to meet rapid development of the subject and modern quantum mechanics instead of the atomic approach. This is distinctly a theoretical college text, planned for junior, senior and graduate college students. Some of the subjects are: The Mechanical Picture of a Perfect Gas, The Mean Free Path, Distribution of Molecular Velocities, Van der Waal's Equation, Brownian Movements, Kinetic Theory and Application to electrical and magnetic properties of molecules and to conduction of electricity.

Vibration

MECHANICAL VIBRATIONS (1934)—*By J. P. Den Hartog, asst. prof. of Applied Mechanics, Harvard University. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y. 390 pages, 6 x 9 in. Cloth covers. 282 illustrations. Indexed. Price $5.*

Developed from lectures before the Westinghouse Design School, this text is a complete account of vibration as applied to mechanical engineering. Besides giving the general theory in a readily understandable form, it covers in some detail the principal applications to water wheels, steam turbines, automobiles, airplanes, diesel engines and electrical machinery.

The author has evidently tried to meet the needs of practicing engineers, as well as students, for he has included as illustrations a number of cases of vibration trouble.

Important results are graphed, and topics discussed include only those of practical interest. A fairly complete set of references is included. To use the text, some knowledge of dynamics and calculus is necessary, but none of differential equations, for where they are used they are discussed in detail and for definite integrals alternative graphical solutions are provided. For use in class work, the book includes a number of simple experiments and problems at the end of each chapter.

Piping Design

MANUAL FOR THE DESIGN OF PIPING FOR FLEXIBILITY BY THE USE OF GRAPHS.—*By E. A. Wirt, S. Smith, E. T. Cope. Published by the Detroit Edison Co., 2000 Second Ave., Detroit, Mich. 130 pp., 9 x 11 in. Cloth. Illustrated. Price $2.50.*

This book is a result of painstaking study by Detroit Edison Co. engineers into the problem of providing flexibility in piping systems. It places in the hands of engineers all the data necessary for the correct proportioning of ten of the most commonly used shapes of pipe structure. The manual is divided into two parts. Part I contains curves and equations, which apply to pipes of all sizes and made of all practicable materials operating at any temperature at which material of the pipe may be continuously operated, and subjected to bending stresses of any value up to the practical limit, taking into account the material of the pipe and the temperature at which it is to operate.

Part II contains curves from which the correct lengths of the elements of eight of the ten shapes of structures used in Part I may be read directly when the structure is made of mild steel and the maximum bending stress is 12,000 lb. per sq.in. The charts from Part II are very easy to use and are recommended for general use, unless the requirements of the problem are not satisfied by this.

An example of one of these charts and its use was published in the April, 1933, number of POWER. The manual is a revision, with additions, of a paper presented by the authors before the meeting of the American Society of Mechanical Engineers in Chicago, June, 1933.

Diesel Handbook

DIESEL HANDBOOK (1934)—*By Julius Rosbloom. Published by Diesel Engineering Institute, 443-445 Hoboken Ave., Jersey City, N. J. 352 pages, 4¾ x 6¾ in. Flexible fabrikoid covers. Many illustrations and tables. Sold as part of the author's diesel course.*

The "question and answer" method is used throughout this handy-size book. The range of material is very complete, comprising everything from a discussion of heat through gases and liquids to oil storage, valves, pumps, electrical subjects, practical calculations, types and designs of diesels, engine operation, auxiliaries, marine practice, fuel and lubricating oils, accessories, electrical transmission, operating troubles and causes, formulas and tables, indicator practice, diesel trucks and automobiles, points to remember.

It is unfortunate that the book was not more carefully checked and edited. Language in many places is confused, even misleading, and parts of the text are inaccurate. An example of the first is on page 98 in the section titled "Mensuration." The second sentence reads: "Taking a triangle first, as this has the least number of sides of any figure, we discover that all the sides are equal, hence it is called an equilateral triangle." Obviously all triangles are not equilateral and do not have equal sides. The remainder of the explanation is also confused.

One glaring inaccuracy occurs on page 124, after the author has begun to answer a question regarding the events of the 4-stroke cycle. The cross-sections he uses to explain the events are those of a 2-cycle engine, although his discussion is of a 4-cycle unit. The caption for the page reads: "Demonstrating the events during the cycle of two-cycle performance." On the facing page is a correct 2-cycle diagram.

Diesel Fuel Research

SAE-ASME Diesel Fuel Research Committee Report (1934)—*Prepared by the special committee in mimeograph form. Copies available from Secretary M. J. Reed of the Committee, 2 West 45th St., New York, N. Y. Price, $0.50.*

This report surveys the present fuel oil market roughly, estimates the amount of fuel oil now being used, indicates what may be expected several years from now, lists past efforts toward fuel standardization, gives the present status of builders' specifications, and discusses ignition characteristics. In the latter discussion, descriptions are given of the crucible and bomb methods for finding self-ignition temperatures, engine test methods by critical compression ratio and ignition lag methods, a testing engine, standardization of engine test conditions.

Four appendices detail the history of research on ignition characteristics and interpret the results.

Technomics

Technics and Civilization (1934).—*By Lewis Mumford. Published by Harcourt, Brace & Co., New York. Cloth. 495 pages, 5 x 9 in., including chronological list of inventions, bibliography and index. illustrated with photographs. Price $5.*

Obviously the work of years, this volume by Mumford is big in meaning, as well as in dimensions. By comparison, the numerous popular books on the "machine age" are just so much chicken feed. Even other serious attempts to give the philosophical meaning of machinery seem thin or one-sided after reading this. "Technics and Civilization" is as broad as life itself, founded on a profound study of the history of all types of civilizations, of all degrees of mechanization. Mumford stands utterly apart from the two most common groups of writers in this field: those who glorify the present mechanized society uncritically and those who cast all common sense to the winds in blaming man's most obedient and efficient servant for human frailties. Mumford portrays the machine and its development with a keen understanding of its actual and potential benefits, but he gives no quarter to the stupidities and cruelties that have accompanied its use. His conclusions, pointing to the proper and essential place of technology in a future civilization dedicated to human values, should be of extreme interest to all thoughtful engineers.

Steam Boilers

Die Dampfkessel (Steam Boilers) (3rd Edition)—*By R. Spalckhaver and Albrecht Rüster. Published by Julius Springer, Berlin. 190 pages, 7 x 10 in. 338 illustrations. Price 32.00 reichsmarks.*

Since the second edition of this treatise appeared in 1924, new materials and new forms of construction have been accorded official recognition by the German authorities. This step has given the builders of boilers greater freedom to avail themselves of the fruits of scientific research. Competition has brought noteworthy progress, especially as to heat transfer and the use of high-pressure steam.

To revise the book so as to incorporate these recent developments would have necessitated the republication of much of the previous material. In the interest of economy to the owners of that edition it was decided to issue a complementary volume covering the progress of the past decade, continuity of treatment being established by references to the original.

The subject matter, which begins with a discussion of combustion and the laws of heat transfer by conduction and by radiation from solids, flames and gases, is not confined to the design of boilers but takes in the entire boiler-room installation, including furnaces, superheaters, steam accumulators, air preheaters, feed water heaters, pumps, water purifiers and other accessories. Methods of computation are shown with the aid of a variety of numerical examples and considerable space is devoted to details of construction. Cuts of generous dimensions and exceptional clearness are made possible by the large page size, printed 7 x 10 in.

BRIEF REVIEWS

Water Resources Paper. vol. 64. *The Dominion Water Power and Hydrometric Bureau of the Department of the Interior of Canada, Ottawa, has recently issued this volume, which deals with surface water supply of Canada.*—This number contains results of investigations made by the Dominion Hydrometric Survey during the climatic years Oct. 1, 1927, to Sept. 30, 1929, for the Provinces of Ontario and Quebec. Text both in English and French.

Results of Municipal Lighting Plants (3rd edition). *By C. F. Lambert. Published by the Burns & McDonnell Engineering Co., 107 W. Linwood Blvd., Kansas City, Mo. 160 pages, 6x9 in., paper covers, graphs and charts. Price, $1.*—This electric rate book shows what 363 representative cities pay for electricity. It gives a unique and informative record of rates, earnings, operating expenses, net profits, kilowatt-hour production and other information pertaining to the use and cost of electricity.

50 Jahre Berliner Elektrizitaets Werke, 1884-1934. (50 years of the Berlin electrical works)—This is a 250-page, 8½x12-in. presentation book reviewing developments in equipment, plant service and policy of this organization. Includes a number of supplementary tables and chronology of development.

Station Piping, 1934. *Publication No. B5 of the Edison Electric Institute. 420 Lexington Ave., New York, N. Y. Price, 60 cents to members and $1.50 to nonmembers.*—Report of the Turbines, Auxiliaries and Piping Sub-committee of the Prime Movers Committee, includes general statements on experiences with welded and general piping, development of bolting and piping materials, investigation of welded pipe joints for high-pressure, high-temperature service, experiences with this kind of piping in valves at Delray No. 3, Trenton Channel, Deepwater (Houston, Texas) and Edgewater stations, qualification tests for welders, and manufacturers' statements covering welded and general piping practice.

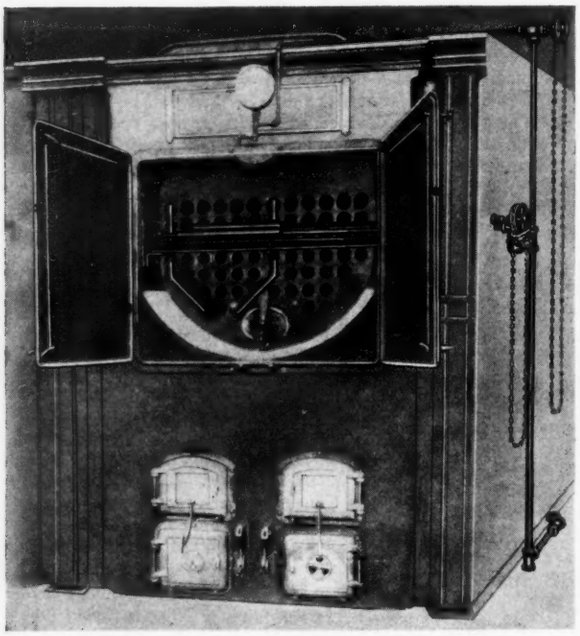
Condensation of Moisture in Flues. *By William R. Morgan, Special Research Assistant in Ceramic Engineering, University of Illinois. Published as Circular No. 22 of the Engineering Experiment Station, University of Illinois, Urbana. Price, 30 cents.*—This is a 22-page, 6x9-in. paper-covered bulletin reporting an investigation showing calculations of moisture content of flue gases resulting from the combustion of 23 different kinds of fuel.

Underfeed Combustion, Effect of Preheat, and Distribution of Ash in Fuel Beds. *By P. Nicholls. Bulletin 378 of the United States Department of the Interior, 76 pages, 6x9 in. Paper covers. For sale by the Superintendent of Documents, Washington, D. C. Price, 10 cents.*—This publication deals with fundamental principles not brought out previously, and should be very useful to combustion engineers. It is a necessary step before further studies on fuel beds as occurring in service.

Geology at Dam Sites on Huntington Creek, near Huntington, Utah. *Issued by the United States Geological Survey, Department of the Interior.*—The report also contains three figures showing geology at the sites in plan and in cross-section and three photographs of the sites.

Neuere Entwickelung des Dampfkesselbaues (recent developments in the construction of steam boilers). *By Ernst Lupberger. Published by Verlag Stahleisen, Düsseldorf. 26 pages, 28 illustrations. Price 3.90 reichsmarks.*—Remarkable progress has resulted from the efforts of designers of steam boilers to avail themselves of the results of scientific research, replacing more empirical methods of former times. These researches cover a great variety of topics which the author reviews. The process of steaming has been investigated by means of motion pictures, and equations of heat transfer have been deduced, of exponential form. Studies of steam and water flow, of the movement of steam bubbles relative to the water, and of the process of combustion have influenced the design of super-heaters, made possible the reconstruction of existing boilers for increased output, and influenced the design of combustion chambers and passages. Tensile tests at high temperatures have been made to show the properties of special alloys. A table is reproduced in the article. Several pages are devoted to the construction of recent large boilers and furnaces and data are given on 17 German installations and 14 in the United States. The paper closes with a discussion of chemical problems. In his resume of present trends, the author considers especially the possibilities of power units comprising a turbine and its associated boiler or boilers. The paper is a reprint of a series of articles that appeared originally in the publication, "Stahl und Eisen."

WHAT'S NEW IN PLANT EQUIPMENT



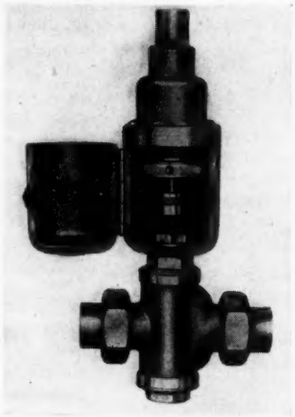
Soot Blower for H. R. T. Boilers

Diamond "Strait-Line" soot blower for horizontal return tubular boilers is arranged so that every tube comes directly into path of steam jet, is thus thoroughly cleaned as elements traverse boiler head. This direction action assures clean boiler and reduces amount of steam required for cleaning. Unit is operated by opening valve in the steam line and rotating chain wheel which actuates element-moving screw. Construction simple and rugged, with minimum number of moving parts. No swivel joints and no flexible hose connection. Can be installed either in smoke-box extension or under return arch. Does not interfere with clean-out doors and is easy to install. Bulletin No. 354.

Diamond Power Specialty Corp., Detroit, Mich.

Sylphon Refrigeration Temperature Regulator

This unit is for brine-cooled refrigeration systems, cold storage room, refrigerator boxes, drinking water cooling systems, etc. Valve is designed to prevent frost from forming on valve stem, and entering stuffing box, thus avoiding sluggish functioning. Metal housing completely incloses valve steam and packing nut. This inclosure, with access door illustrated, is filled with asbestos saturated with ammonia compressor oil. This construction permits valve stem to work freely at temperatures as low as 70 deg. below zero. Unit called "Freeze-Proof."



Fulton-Sylphone Co., Knoxville, Tenn.

Electrode

Type W-22 general purpose welding electrode is of heavily coated or shielded-arc type, producing welds of quality required for Class I pressure vessels under A.S.M.E. Boiler Code. May be used in any position with deep penetrating qualities, for butt or fillet welds.

General Electric Co., Schenectady, N. Y.

Vacuum Gage

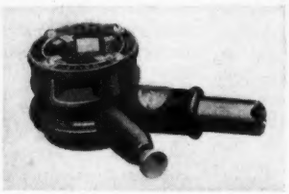
"Tru-Vac" gage reads changes in vacuum. Will also indicate presence of water and other vapors. Continuous day-by-day record may be had by connecting recording device to it. Adaptable to any vacuum pump or system and quickly installed. Can also be used for filling, as it will indicate exact pressure of gas-filled devices.

Continental Electric Co., St. Charles, Ill.

Portable Thermometer

This lightweight portable recording thermometer furnished with either self-contained or long-distance type thermometer in 8- or 10-in. case. Unit illustrated is 10-in. self-contained, Class II instrument with range of —25 to +125 deg. F. Frosted silver or dull black laquer finish. Companion instrument for recording pressures. Units may be removed from stand by unscrewing three bolts. Chart disk can be removed by slipping wedges.

Foxboro Co., Foxboro, Mass.



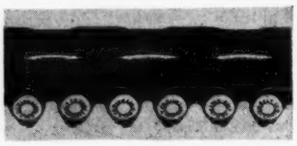
Ratchet Threading Tool

No. 11 tool now has capacity of ⅛ to 1¼ in. Separate die head and dies for each size, good for close-corner work.

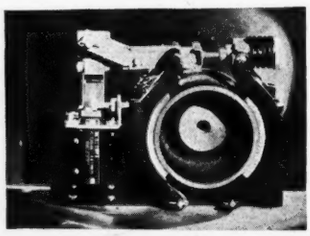
Toledo Pipe Threading Machine Co., Toledo, Ohio.

Silent Chain

"Silverstreak" is "dressed-up" version of Link-Belt silent chain created by bluing most of chain and treating washers and guide bars to give them silvery appearance. All standard types for industrial first-reduction drives, including side-flanged, middle guide, no back bend and duplex types.



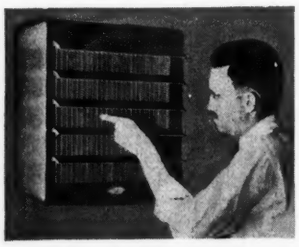
Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.



Small Electric Brakes

These small a.c. and d.c. solenoid-operated brakes available in three sizes with torque ratings ranging from 3 lb. ft. to 75 lb. ft., in accordance with NEMA standards. Brake wheel is relatively large, allowing low total brake-shoe pressure and long even wear friction surfaces, as well as low stresses on pins and pivots and use of small operating solenoid. A.C. and d.c. brakes interchangeable. Bulletin No. 511.

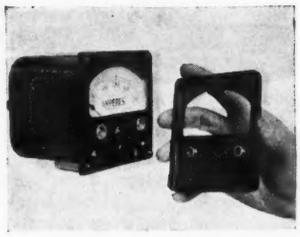
Cutler-Hammer, Inc., Milwaukee, Wis.



Unit Heaters

Series 3 unit heaters have careful exterior design and are finished in dark brown, morocco-like textures. Electric welded one-piece cabinet with integral reinforcing members, streamline tubes, patented fins, resilient motor mountings, header tanks with integral baffles to insure even steam distribution throughout element. Specially designed full-floating mountings maintain alignment of heating element within cabinet, eliminate expansion stresses and protect element from piping strains. Efficiencies of heat-transfer surface, air velocities and final outlet temperatures are balanced. Complete line in capacities up to 1,200 sq.ft. E.D.R. steam.

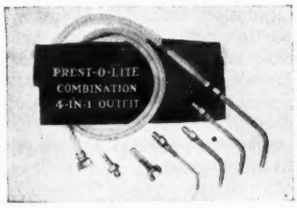
Fedders Mfg. Co., Buffalo, N. Y.



Switchboard Instruments

Type K includes complete line of small indicating meters in rectangular cases for a.c. or d.c. Intended primarily for power station miniature switchboards, and supervisory control, but can be generally used where small size is desirable. Movements same as in larger instruments, but case is only 4 x 4¼ in. Dials illuminated by concealed miniature lamps. Cases flush-mounting type. Mechanism on molded composition sub-base, snap-on front avoids screw-heads. D.C. units, called Type KX, are permanent-magnet moving-coil type. A.C. ammeters and voltmeters, called Type KA, are repulsion moving iron type. Type KY watt-meters, frequency meters and p.f. meters operate on moving coil electrodynamometer principle.

Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.



Combination Outfit

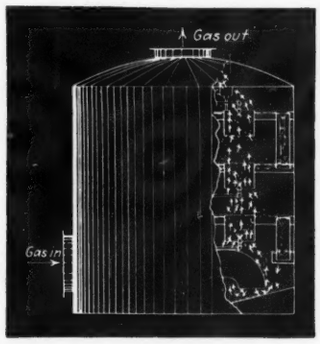
Prest-O-Lite 4-in-1 outfit has four stems (omits soldering unit) and waterproof fabric carrying case. Stems for light soldering, fine soldering, medium soldering, and heavy soldering. Also outfit for soldering copper pipe.

Linde Air Products Co., 30 E. 42nd St., New York, N. Y.

Gas Cleaners

B-T gas cleaner Type 2 removes dirt and dust from gas. Dust is usually well sand, construction dirt and pipe scale. This unit is horizontal cylindrical tank containing bed of iron turnings continuously washed with oil from an overhead trough. Oil is lifted to trough from bottom reservoir by the gas itself. Gas strikes oil-covered bed at fairly high velocity, throwing into oil suspended dust and dirt, and is further washed by bed of turnings. No oil mist or spray. Unit 4 ft. in diameter by 14 ft. long will handle 1,800,000 cu.ft. of gas per hr. at 250 lb. per sq.in. with low filter resistance. Sizes to handle any volume.

Type 3 unit is vertical, of large capacity, and adapted for clean-



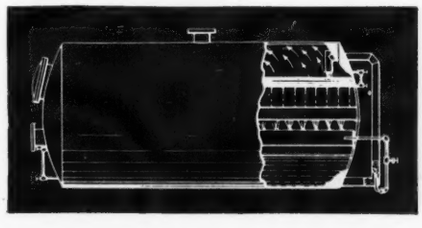
ing gas with large quantities of solids in suspension. Particularly suited for cleaning blast furnace gas.

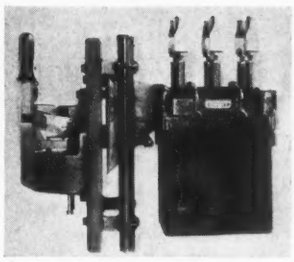
Burrell-Mase Engrg. Co., Law & Finance Bldg., Pittsburgh, Pa.

Dusty Atmosphere Capacitor

Totally - inclosed, non - inflammable capacitor for dusty atmosphere is treated and filled with Pyranol, which is non-inflammable and has high insulating and dielectric properties. This material permits capacitor of smaller size and weight. Dielectric itself is hermatically sealed, and connections are brought out through bushings into dust-tight box on top. Dust-tight box provided with conduit holes, each fitted with dust cap, and contains standard N.E.C. indicating fuses which can be inspected by removing gasketted cover. Cover held in place by two wing nuts on hinged studs.

General Electric Co., Schenectady, N. Y.





Oil Circuit Breaker

Type E-47 medium-capacity switchboard-type oil circuit breaker for 600 amp. at 7,500 volts or 800 amp. at 2,500 volts in 2-, 3- and 4-pole units. Interrupting capacity rating 25,000 kva. Flexible in mounting arrangements. May be manually, solenoid or universal motor operated. High-speed breaker of enclosed-mechanism type. Oil-tight if desired. Bakelain bushings used. New arcing contact system uses butt contact with arcing tips of drop-forged type. Steel plate tank, cast frame, barriers between phases and full-length tank liners.

Condit Electrical Mfg. Corp., Hyde Park Station, Boston, Mass

Centrifugal Compressors

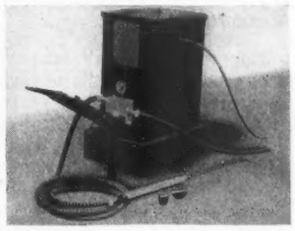
Single-stage Type OIB centrifugal compressors and exhausters have their own shafts and bearings, thus are suitable for direct connection to standard electric motors or steam turbines, without special shaft extensions. Also adjustable to V- or flat-belt drive. Impellers in aluminum or carbon steel, special if desired. Open-type impellers in smaller sizes, closed in larger. Casings cast iron, but special alloys if desired. Anti-friction bearings in smaller sizes, sleeve bearings in larger.

Roots Connersville Blower Corp., Connersville, Ind.

Remote Control for Arc Welders

With this device, known as "Lincontrol," operator taps electrode on work several times and voltage is automatically raised. Larger number of taps lowers voltage. In this way the operator can work at any distance from machine and regulate current accurately without making trips back and forth to adjust controls. No additional cables of other apparatus needed.

Lincoln Electric Co., 13034 Coit Rd., Cleveland, Ohio.



Vapor Spray—Cleaner

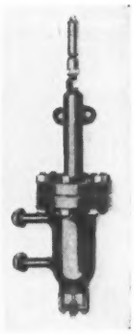
Fireless Hypressure Jenny is portable and only 20x45x52 in. Uses plant steam instead of producing its vapor by means of an oil-fired generator. Unit consists of water or solution tank with automatic float valve, rotary pump direct-connected to a fractional-horsepower motor driven from light socket. Pressure range 50 to 250 lb., and spray variable from mist to heavy cutting spray by hand control.

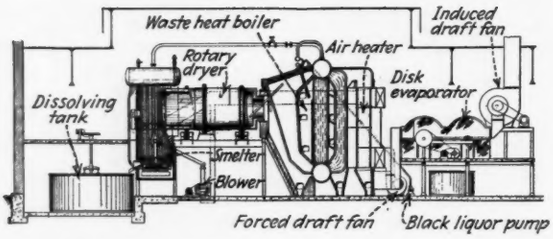
Homestead Valve Mfg., Co., Coraopolis, Pa.

High-Low Water Alarm

"Diamond" Model S alarm operates on pressure differential created by two inclined vertical pipes, both extending into an inclined cylinder connected to boiler drum. Lower end of one pipe is at low-water level, of other at high-water level, creating pressure differential when water level is between. If pressures equalize, indicating low or high water, diaphragm between pipes is centered, allowing spring preset on whistle valve to sound whistle. Can be installed in existing boilers.

Diamond Power Specialty Corp., Detroit, Mich.





By-product Steam Recovery Unit

Improved Murray-Waern system produces 10,000 lb. of high-pressure steam per ton of paper pulp in paper-mill heat-recovery work. Black liquor, after passing through multiple-effect evaporator, enters disk evaporator. Then is pumped to rotary drier through water-cooled pipe. Liquor is dried in rotary drier and part of combustible element burned out. Residue delivered to smelter where remaining combustible is burned out and chemical ash fused and drained to dissolving tank. Gaseous products of combustion pass through drier, waste-heat boiler, air heater, disk evaporator and induced-draft fan to atmosphere. Heat of combustion, less that required to evaporate mixture, recovered as high-pressure steam. Water walls in strategic places and air-sealed lip at end of rotary drier.

Combustion Engrg. Co., Inc., 200 Madison Ave., New York, N. Y., in association with D. J. Murray Mfg. Co., Wausau, Wis.

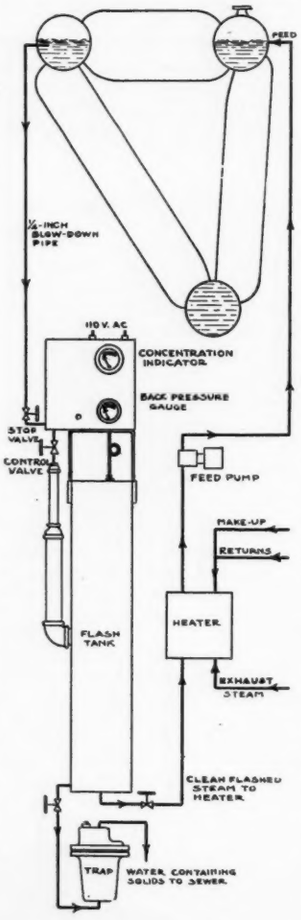
Alternator Air-Agitating System

C-A system of air agitation and water circulation for ice making has air circulate to one-half of cans in tank for fixed length of time, then to those in other half, then back to first group, etc. Special motor-driven alternator device switches air usually about every 30 sec. Air in header, laterals and tubes is "trapped" in as agitating flow is shut off, thus avoiding water rise in tubes and permitting agitation to start as soon as air is switched on. This reduces air consumption and reduces size of blower and motor. System also has air tube which divides flow at bottom into two streams in opposite directions. Flexible rubber tube connects lateral and tube, permitting tube to be constantly vertical, easy changing or removal. Illustration shows system adapted to a typical plant.

Carbondale Machine Co., Carbondale, Pa.

Continuous Blowdown System

Franklin system consists of control valve for regulating quantity of blowdown, concentration indicator for reading value of concentration at any moment, special design flash tank for heat and water recovery and trap for discharging discarded water. Simple to operate; operator simply reads concentration, then opens or closes control valve as necessary. Blowdown taken from near end of one steam drum just under disengagement surface. Also removes some solid matter in suspension and oil and organic matter. Full data in Bulletin 102. Piping hookup shown.



Franklin Power Specialty Co. 1242 East 113th St., Cleveland, Ohio.

Direct-To-Furnace Type Indicator

6-in. cast-iron wallbox with slot container for heat-resisting glasses cast integrally. Dust-proof and airproof with mica glasses fitted in sheet metal mounting. Cap covering when in place. Aluminum door has standard 4 x 6-in. furnace blue glass. Openable to view medium fires through clear mica. Cast iron baffling fins intercept fly ash; arranged in circle about opening and extending in 1¼ in. each with 4 holes drilled through further to intercept ash. Units installed viewing under ignition arches, in side walls of chain grate stokers where fuel should be all burnt before going into ashpit, or rear walls of forced-draft underfeed stokers to see agitator and ash dump. In latter case can be mounted on inspection doors, then doors can be sealed. Close-up view or periscopic heads available.

A. E. Powell Smoke Combustion & Furnace Indicator Co., Cedar Falls, Ia.

Portable Rotary Pump

High-speed rotary displacement pump driven by gasoline engine and entire set mounted on trailer. DeLaval IMO pump, 1,675 r.p.m., 90 g.p.m., against 495 lb. per sq.in. pressure with suction lift equivalent to 14 in. of mercury. Pump weighs 398 lb., and complete set with 60-hp. engine weighs 2,000 lb.

DeLaval Steam Turbine Co., Trenton, N. J.

Test Pliers

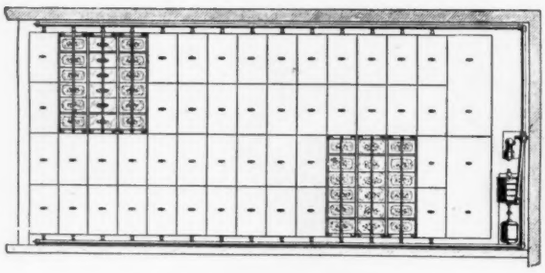
This combination tool permits any one to extract fuses and test open circuits, blown fuses, base receptacles, grounded fixtures, etc. Made of Bakelite and fibre. Testing device is carbon lamp in series with 1,600-ohm resistance, and rated for voltages of 110 and 250, although carbon lamp will light on 65 volts and without resistance has a range of 30 to 110 volts. Carbon lamps take 0.09 amp., and will give positive indication if there is current on the line. Moisture or a high resistance leak in panel will not light carbon lamp. Can be used for pulling fuses with perfect safety up to 200 amp., and for testing from 70 to 250 volts.

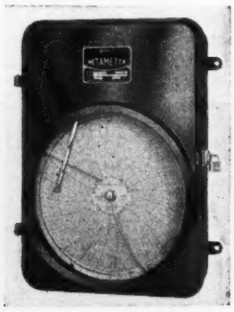
Star Fuse Co., Inc., 168 Centre St., New York, N. Y.

Telemetering System

This long-distance transmitter and recorder operates on chrono-flo system. Consists of transmitter, recording receiver, relay and rectifier box at receiver, and 2-wire line connecting units. Will record temperature, pressure, liquid level, or motion 250 miles from source without distortion. Transmitting element detects measurement and converts it into time function. Thus 2-wire circuit carries impulse during portion of a fixed time interval. This interval is provided by a synchronous motor-driven continuously rotating cam. Time that circuit is closed during each cam rotation is proportional to amount condition being measured has risen above minimum measurement. Also duration of contact off is proportional to amount condition has dropped below maximum measurement. Recording unit translates these into upward or downward movement of pen-positioning mechanism. System requires a.c. at each end. Recording receiver uses 12-in. chart as is housed in moisture-proof rectangular Model 40 M case.

Bristol Co., Waterbury, Conn.





Refractory Facing

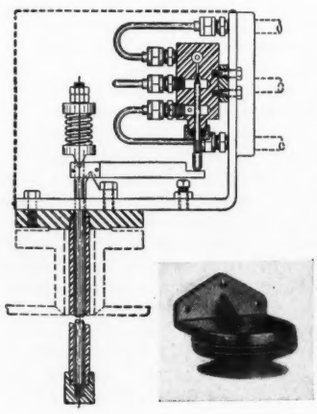
"Fire-Drake" facing for refractories unites itself inseparably with refractory; does not peel off or permit linings to disintegrate. When used in coal-burning furnaces along side walls of fire bed, prevents slag penetration into joints as well as lessening destructive action of slag on brick, thus materially lessening spalling. Provides protection to refractory from infiltration of high temperatures and gases, as well as actual flame penetration, and forms smooth jointless monolithic lining, which prevents loosening and working out of bricks from setting. Also acts as sealer and insulator, thus reducing fuel costs through increased evaporation and increased reflection. Same coefficient of expansion as fire brick, and affords protection up to at least 3,000 deg. F., or better, even under drastic temperature changes. Packed in 5-gal. drums in soft paste form, one gallon covering about 25 sq.ft. Must be fused by subjecting it to temperatures of 1,800 to 2,000 deg. F.

Simmons Refractories, Ever-Ready Bldg., Thompson Ave. & 30th St., Long Island City, N. Y.

Master Regulator

"Thermo" master regulator controls steam temperature after it has passed through a reducing and desuperheating station. Consists of bi-metal thermostat. Operating element in steam line on outlet side of desuperheater, power developed being transmitted to 3-way valve. Valve admits pressure to or relieves pressure from main diaphragm-operated valve controlling water supply to desuperheater. Controls temperatures as high as 1000 deg. F., safety elements for protection in case of water failure. Can also be used on any temperature control system where one large or several small valves are used and accurate temperatures are required.

Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.



Hot-Material Belt

Golden Ply hot-material belt has 85% greater flexing life and special cover offering greater resistance to abrasion even after exposure to heat. Belt shows 30% increase in flexing life after aging, rather than usual decrease.

Mechanical Rubber Goods Div., B. F. Goodrich Rubber Co., Akron, Ohio.

Air-Conditioner

This unit replaces average steam radiator. Is 28⅛ in. high, 29¾ in. long, and 13⅜ in. wide. Two twin centrifugal fans, connected to ⅛-hp. electric motor, force air up through water coils into a chamber where air passes through two sprays of water, which washes under pressure. Unit cleans air and dehumidifies it in summer, and humidifies it in winter. Air forced through unit top at rate of 600 cu.ft. per min. Unit has common heating and cooling coil, using steam or hot water for heating and any type of refrigerant for direct expansion for cooling. Known as "Airtemp," and developed in Chrysler laboratory. Manufactured by Amplex Mfg. Co., Division of Chrysler Motors, and sold by:

Temperature Corp., Chrysler Bldg., New York, N. Y.

Waterproofing Liquid

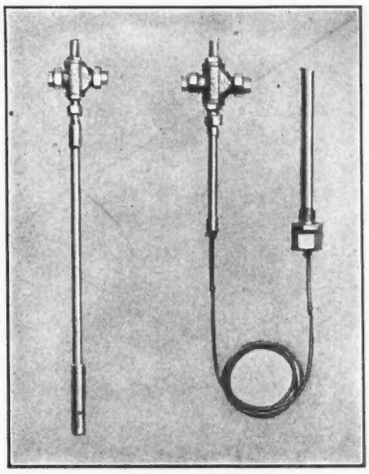
Stonhard Stontite liquid stops leaks ranging from streams as large as your fist to occasional seepage in foundations, walls, elevator pit floors, tunnels, pools, reservoirs, dams, or anything else constructed of concrete. Not necessary to remove hydrostatic pressure, for material is used on open side of structure.

Stonhard Co., 401 N. Broad St., Philadelphia, Pa.

Plunger-Type Relay Compound

Compound can be used for new relays or in place of leather bellows in older units. Gives greater reliability and longer life and requires no oiling or dressing. Accelerated aging tests show depreciation less than 25% in 42 years, while depreciation twice that still permits proper operation.

General Electric Co., Schenectady, N. Y.



Temperature Regulators

Type KR-15 (left) Sarco self-operated temperature regulator is intended for control of brine cooling coils as used in refrigeration and cold storage. Temperature-sensitive bulb is rigidly attached to valve, omitting customary flexible connecting tubing. Valve is "packless"—no stuffing box, thus preventing frosting in service, causing valve-sticking. Key used to change temperature.

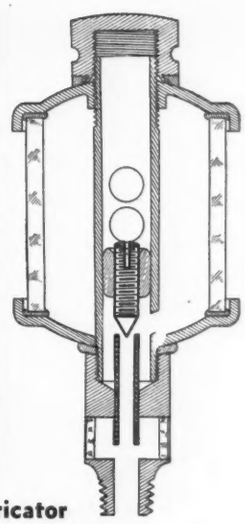
Type TR-20 (right) is new junior model tank regulator in three sizes—⅜, ½ and ¾-in. Has small bulb fitted with union connection and is furnished with short length of connecting tubing. Permits use of automatic temperature control on equipment for which standard regulator is too costly.

Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

Gas-Engine-Driven Welder

Close-coupled gas-engine-driven "Shield-Arc" welder is of 300 amp., 40-volt capacity. Generator is mounted on engine housing with drive lined up on hardened steel and driven on cushioned rubber. Special idling device cuts engine speed when arc is broken.

Lincoln Electric Co., Cleveland, Ohio.



Lubricator

1,000 Series Victor automatic force-feed lubricator has cadmium-plated steel body replacing brass for greater tensile strength. New sight feed provides double visibility, showing reservoir supply as well as rate of feed. Larger filler tube. New top stamping, eliminating former hex nut. New cap including patented washer retainer, eliminating cap-retaining wire. New valve control inside filler tube discourages tampering with initial adjustment. Air-tight construction.

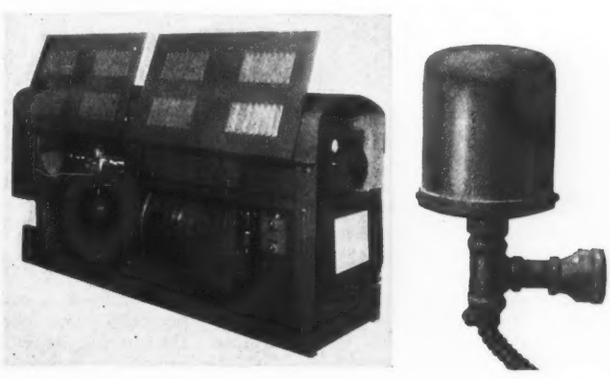
Victor Lubricator Co., 368 N. Michigan Blvd., Chicago, Ill.

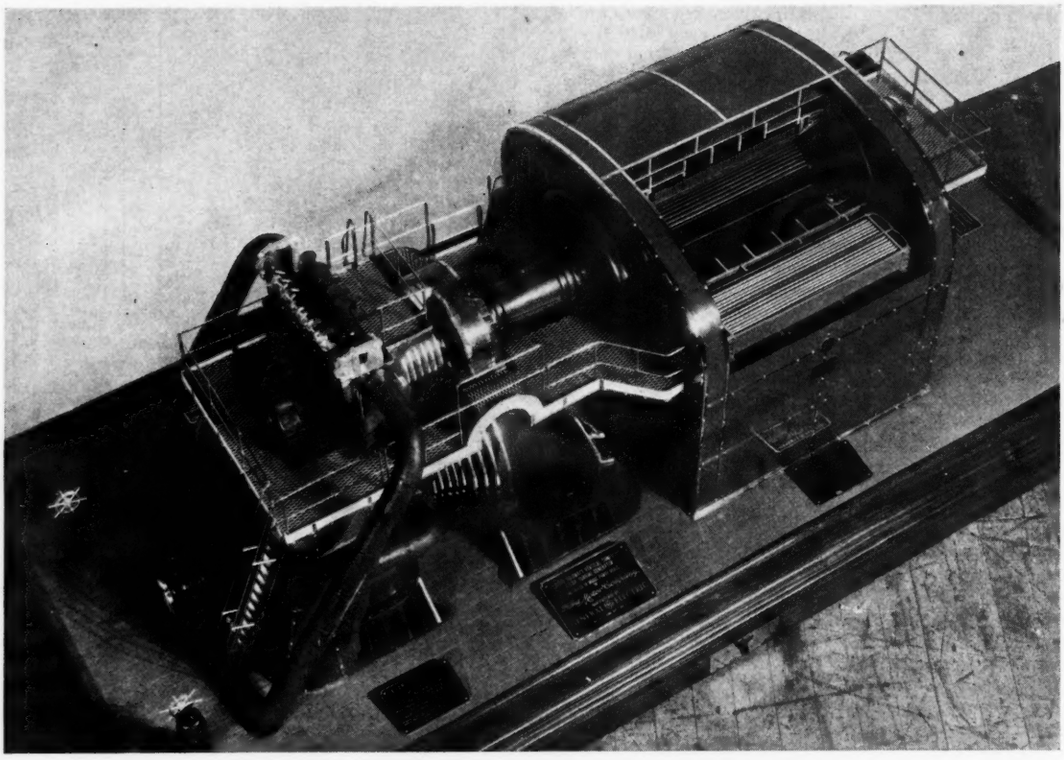
Temperature Control

"Weatherstat" is an outside control responding to all four weather factors—temperature, wind direction, wind velocity, and solar radiation. Can be used in any type of building having any of the following types of heating systems: steam, vapor or hot water, forced circulation.

Unit consists of mass of iron sufficient to obtain the necessary thermal capacity. Iron is shaped to contain thermostatic element with the necessary electric contacts, and is arranged to house small electrical heating element.

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.





An operating model of the first 110,000-kw. vertical-compound steam turbine-generator set for River Rouge plant, opened to show interiors of turbine and generator. The new unit will be similar in appearance but more efficient in design and operation

POWER LINES

Ford and Others Buy Power Units; Sales Show Increasing Business Pace

FORD MOTOR CO. has purchased units to double capacity of its River Rouge power plant, to include a second 110,000-kw. turbine-generator, a high-pressure boiler and necessary auxiliary equipment, and a 15,000-kw. turbine-generator. To cost $5,500,000, this increase will bring the capacity of River Rouge to 2,200,000 lb. of steam per hr. The new 110,000-kw. unit, first large unit to operate at 1,200 lb. and 900 deg. F., will incorporate several new engineering features which increase its efficiency over that of the 1930 unit which it duplicates. The earlier unit ran at 725 deg. F. The new boiler likewise steps up the 700,000 lb. per hr. and 725 deg. F. of the 1930 unit to 800,000 lb. per hr. and 900 deg. F. The new turbine will also be a vertical-compound unit, with the high-pressure turbine and generator mounted directly on top of the low-pressure turbine and generator, each element to have a capacity of 55,000 kw. at 1,800 r.p.m. The unit will be 57½ ft. long over-all, 23 ft. wide (maximum) and less than 21 ft. high from the floor level. Approximate weight is 2,000,000 lb. Thus space occupied will be about a quarter cubic foot per kilowatt. Less than a pound of coal will be burned per kilowatt-hour generated. Complete technical rating for the large unit is 110,000 kw., 80 per cent p.f., 13,800 volts, 1,800 r.p.m., 3-phase, 60-cycle, with steam at 1,200-lb. gage, 900 deg. F. total temperature, 1 in. absolute back pressure. Steam will enter the upper unit at 1,200 lb. and 900 deg. F., and because of the high initial temperature will not be reheated before entering the low-pressure unit as has been done heretofore. Air coolers will be built integral with the generators and will be connected so that heat losses in generators will be recovered by the feedwater. The boiler will generate steam at 1,400 lb.

The 15,000-kw. turbine will be a non-condensing unit delivering process steam to the factory at 250 lb.

Combustion Reports Many Orders

A number of other outstanding power projects have been announced during the month, as well as a noticeable increase in purchases of general power plant equipment. Combustion Engineering Co., Inc., for example, included the following orders in its report: the largest 1,400-lb. steam-generating unit ever built, to go into Ford's River Rouge plant; two large boiler units for Detroit Edison Co.; two complete steam-generating units for U. S. Industrial Alcohol Co.; 64 welded drums for Naval boilers; two 50-ton chemical and waste-heat recovery units for a Virginia pulp mill; two steam generators for a public utility in Nankin, China; five water-cooled furnaces for duPont; four boilers for a Texas sulphur company; other units for a hospital, a flour mill and a PWA project. In addition to these, the company has listed a number of stoker and small boiler sales.

Riley Sells Complete Plants

Riley Stoker Corp. is installing a complete steam-generating unit at the Container Corp. plant at Manayunk, Pa. The new unit consists of a Riley boiler, water-cooled furnace, superheater, air heater, pulverizers and burners, and is designed for a maximum steam output of 200,000 lb. per hr., 500 lb. pressure and 625 deg. F. steam temperature. The contract also includes revamping of the company's two present 7,500-sq.ft. Riley boilers now equipped with multiple-retort stokers. These boilers are now being equipped with water-cooled furnaces and Riley pulverizers and burners and will develop well in excess of 65,000 lb. of steam per hr.

Riley has also recently closed a contract with Titanium Pigment Co. for its Sayreville, N. J., plant for two 125,000-

lb. per hr. complete Riley units, consisting of pulverizer, superheater, water-cooled furnaces, air heaters, flue gas scrubbers, pulverizers and burners. Steam will be generated at 450 lb. pressure and total temperature of 640 deg. F.

Louis Allis Co. has also reported manufacture, testing and shipping of four 100-hp. special motors for Fort Peck Dam within seven working days. That company's sales for the first half of the year are more than three times as great as its sales during the same period of last year.

Bids Received for Bonneville Turbines

Bids have been submitted by three manufacturers to the U. S. Army Engineers in Portland for the initial two 60,000-kw. Kaplan-type hydraulic turbines to be installed in the Bonneville project on the Columbia River. Figures submitted covered turbines and governing equipment and were:

S. Morgan Smith Co., York, Pa.: Turbines, $1,119,331; governing equipment, $73,744; total, $1,193,075.

Pelton Water Wheel Co., San Francisco: Turbines, $1,180,280; governing equipment, $74,800; total, $1,255,080.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.: Turbines, $1,181,285; governing equipment, $70,840; total, $1,252,125.

All bids were on an f.o.b. factory basis. The turbines, of which there will be 10 ultimately, are of the Kaplan adjustable-blade type for operation at heads ranging between 50 and 65 ft. Efficiency guarantees for various heads and loads range between 80 and 88 per cent. Range of speed is 75 r.p.m. Bids will soon be asked for two generators, probably to be 43,200 kw., with bidders permitted to submit figures for voltage of 13,000, 23,000, or 34,000. They will be of the conventional umbrella type with direct-connected exciter and pilot exciter.

Detroit Edison Purchases Third 30,000-kw. Turbine

Carrying out a further step in its program of modernizing Connors Creek plant, Detroit Edison Co. recently purchased the third of three 30,000-kw. turbine-generators which will replace the original three 20,000's first put into operation in the period 1915 to 1917. The new machines, containing parts of the old 20,000's, and the generators and some turbine parts of two other machines (two 30,000's originally installed at Delray and Connors Creek), will make use of the old 32,000-sq.ft. condensing equipment with only minor changes. Four new boilers, stoker fired, will supply 600-lb. 825-deg. steam. Two of these are nearing completion, while the second two have only recently been ordered.

The change in steam conditions and the adoption of a 4-stage regenerative turbine cycle involve complete replacement of all main steam piping (welded throughout) and completely new boiler feedwater heaters and pumps. One new 2,000-kw. geared d.c. auxiliary turbine is ready for erection, and a second will follow in due time.

The boilers themselves, rated at 330,000 lb. of steam per hr., will each supply approximately 33,000 kw. of net plant output in contrast with the original boilers, which were good for about 12,000 kw. each. The superheaters, designed to deliver constant temperature steam over practically the whole operating range, will be of the compensated or "unbalanced" type recently developed for the Trenton Channel plant. Zoned metered air control under the stokers will resemble closely the manually operated air control system first developed at the company's Beacon St. heating plant, but with the added refinement of an hydraulically operated remote-control system which lends itself to equalization by automatic means of the distribution of air laterally across the stoker. The purpose of this is of course the discouragement of thin spots in the fire, with their cumulatively calamitous effects.

The first 30,000 kw. of new capacity is scheduled for starting up in November of this year, with completion of the remaining 60,000 kw. over a period of from twelve to eighteen months.

Administrator Announces PWA Allotments to Aug. 1

Public Works Administrator Harold L. Ickes has made public a summary of PWA activities, showing distribution of recovery funds as the $3,700,000,000 work-creating program approaches peak operations. The Administrator's statement covered all allotments to Aug. 1 at which time it was estimated that 675,000 persons were directly employed on PWA projects. Real expenditures as of Aug. 1 were running close to $39,000,000 a week ("Real" expenditures are the totals of payrolls for direct labor employed on projects, plus the cost of materials delivered at construction sites). Latest reports show that contracts awarded and force account work established (day labor) covering PWA allotments amount to $1,513,239,647, as of July 28. At the same time work estimated to cost $149,557,862 was being advertised for bids. New non-federal construction jobs were being begun at the rate of 50 a week. Virtually all of the $3,700,000,000 funds has been depleted by allocation, and PWA now is looking to RFC for additional funds for loans on non-federal projects. Under the late deficiency act the RFC is authorized to purchase securities now held by PWA up to $250,000,000 worth at one time. Funds thus derived will be allotted as loans to finance non-federal projects still pending before PWA. No new applications are being received.

The complete summary, as made public, was divided as follows: Federal, $1,527,030,517; statutory, executive and special, $1,167,725,666; and non-federal, $975,615,921. Every allotment that has been approved has been included. In the summary, for utilities, including sewer and water system projects, 2,013 allotments amounting to $301,624,570 have been made. This includes 1,639 non-federal projects and 374 federal projects. Allotments for building of all characters numbered 3,580, the total allotment being $362,208,108, about two-thirds of it for non-federal work.

COMING MEETINGS

American Institute of Electrical Engineers—Pacific Coast Convention, Salt Lake City, Utah, Sept. 3-7. General Convention Committee, 1016 Continental Bank Bldg., Salt Lake City, Utah.

Association of Iron and Steel Electrical Engineers—30th convention, held in conjunction with the Iron and Steel Exposition, Cleveland, Ohio, Sept. 18-20. J. F. Kelly, Empire Bldg., Pittsburgh, Pa.

Electrochemical Society — Sixty-sixth convention, Hotel Pennsylvania, New York City, Sept. 27-29. Colin G. Fink, Columbia University, New York.

National Association of Power Engineers—52nd Annual Convention and Power Show, Municipal Auditorium, Minneapolis, Minn., Aug. 27-Sept. 1. Fred W. Raven, secretary, 1140 Lake St., Oak Park, Ill.

American Society of Mechanical Engineers — Annual Meeting, Engineering Societies Bldg., New York, N. Y., Dec. 3-8. Calvin W. Rice, secretary, 29 W. 39th St., New York, N. Y. Also 11th National Power Show, same dates, Grand Central Palace, New York, N. Y. Chas. F. Roth, manager.

National Electrical Manufacturers Association—Annual meeting, Chicago, October 17-20. W. J. Donald, 155 East 44th St., New York.

American Welding Society—14th Fall Meeting in connection with National Metal Congress and Exposition (in cooperation with American Society for Metals), Hotel New Yorker, New York, N. Y., Oct. 1-5. M. M. Kelly, sec., 29 West 39th St., New York, N. Y.

New Yorker Adds Oil Burners

The boiler room of the Hotel New Yorker is now being converted so that the boilers may be fired either by oil or by pulverized coal. For this purpose one Peabody combination coal and oil burner is being installed under each of the four 6,500-sq.ft. water-tube boilers. The orginal coal pulverizers, installed five years ago, when the new Hotel New Yorker pioneered the application of pulverized fuels in hotels, will be retained. The only change in the pulverized coal system will be the substitution of the combination coal-oil burners to permit either bituminous coal or oil to be burned to take advantage of a more favorable price for either fuel.

Galloway Hydro Plant

Work has now so far advanced on the Galloway hydro-electric project, Scotland, that it is anticipated that the first stage will be completed in about three months. Total cost of the undertaking will be £3,000,000 (more than $15,000,000), and about one-half of that sum has already been expended. Work has been undertaken in two stages, the first involving erection of two generating stations in the lower valley of the River Dee, one at Glenlee and the other at Longland. Superstructures of both stations have been completed, and generating sets are being installed. In September or October next the plant will be under test.

London in Dark When Grid Fails

For the first time since its inauguration Britain's electrical grid suffered a serious breakdown on July 29, which dislocated electricity supply in southeast and east England, and places as far as Peterborough in the north, Twickenham in the west and Brighton in the south, as well as parts of London and the home counties, were affected. This was immediately followed in London by another breakdown at the huge County of London electric station, Barking. Parts of east London were entirely without energy for about twenty minutes as a result. The Central Electricity Board has issued the following statement on the breakdown:

"At 11:45 a.m. trouble developed at the Battersea power station of the London Power Company. The whole of the export of that company to the grid system of southeast and east England was interrupted, leaving the remainder of the stations to deal with the full load. Owing to the reduced demand on Sundays fewer stations were in active operation than ordinarily. They would have been able to carry the additional load, but the abnormal 'fault' current suddenly called for was beyond their capacity.

"In order to readjust matters it became necessary to disconnect the stations and start the system up again in sections. This accounts for the variation in the duration of the interruptions of supply throughout the area."

The interruptions varied from half an hour to nearly four hours. The definite cause of the breakdown has not been determined.

Smoke Ass'n Officers

Frank Trumble, smoke inspector of Buffalo, N. Y., has been elected president of the Smoke Prevention Association, Inc., for the coming year. W. E. Koepler, secretary of Pocahontas Operators Association, Bluefield, W. Va., has been elected first vice-president; and Wm. Langlands, master mechanic of the C.& N.W.R.R., second vice-president. F. A. Chambers, chief smoke inspector of Chicago, has been elected secretary-treasurer, and H. V. Carlson, traveling fireman for the Nickel Plate Railroad, sergeant-at-arms.

Boiler Explodes Due to Low Water

On the morning of July 30, 1934, the New Hampshire hills between Concord and Manchester were shaken by a boiler explosion. Three lives were lost and seven persons injured, either by scalding steam or flying debris. The boiler was a fire-tube unit of the stationary locomotive type and had been in service for many years. It was in a semi-portable saw mill and was used to generate steam for an engine. All evidence pointed to the fact that reasonable care had been taken of the boiler as to maintenance and repairs. As the boiler-room attendants on duty at the time of the accident were killed, the exact facts leading up to the direct cause may only be determined by witnesses and examination of the parts of the boiler which were found.

Wreckage of the engine. The boiler flew 500 ft. away

Feed water for the boiler was taken from the Suncook River, then at a rather low level, and the water contained a higher percentage of solids in suspension than usual. Rumors pointed to the fact, and it is entirely possible, that some part of the feed-water system became obstructed. There is little doubt that whatever the actual operating conditions were, the boiler became overheated due to low water. The fact that the three men killed were standing close to the boiler was thought to be an indication that some such operating difficulty was being experienced.

As the boiler overheated, the heads of the staybolts supporting the furnace sheets and the crown sheets were first affected. As these were weakened the crown sheet collapsed. The resultant shock caused the boiler to tear apart into three major sections.

The barrel, tube sheet and tubes went through the side of the boiler room wall to disappear in the river some 100 ft. away. The furnace end, including the side and front wrapper sheets and the dome, went through the opposite wall and went bounding across a field to come to rest about 500 ft. away. This section, weighing about a ton, left a large hole in the ground each time it struck as it bounced along.

Part of the furnace sheet and crown sheet went in still another direction for 300 ft. These sheets showed distinct evidence of discoloration through overheating. Boiler room and mill were completely wrecked, as shown in the illustration. Remains of the engine may be seen.

New York to Entertain American Welding Society

For the first time in years, the Fall Meeting of the American Welding Society is to be held in New York. Ordinarily the Fall Meeting, accompanied by an exposition of welding and other mechanical equipment, is held in a city outside of New York, while the Spring Meeting is always held at the New York home office.

Technical sessions, held at the headquarters in the Hotel New Yorker, will continue from Oct. 1 to 5. Simultaneously an exposition of welding equipment and materials will be held in Commerce Hall (111 Eighth Ave.), in cooperation with the American Society for Metals. This is called the Sixteenth Annual Metals Exposition.

Papers of possible interest to *Power* readers include:

"Use of Polarized Light as Applied to Welding Products," "A Critical Examination of Welded Pipe Materials," "Effect of Peening on Welds," "Welding of Cast-Iron," "Metal Spraying," "Hard Facing," "Flame Machining," "Automatic A.C. Arc Welding Class I Pressure Vessels," "Boiler Welding," "Pipe Welding," and "Testing of Welds."

Ickes Visits Quoddy

PWA Administrator Ickes went to Eastport, Me., two weeks ago to view personally the site of the proposed Passamaquoddy tidal power project for which a $47,000,000 PWA loan has been requested. Last May the PWA Board of Review reported that the time had not yet arrived for development of the project from an economical point of view, but the Board of Public Works has taken no official action so far. The project has also been disapproved by the Federal Power Commission, but its sponsors are still actively pushing it.

Steam Table Conference Here Under A.S.M.E.

The third International Steam Table Conference is to be held Sept. 17-22, 1934, under the auspices of the American Society of Mechanical Engineers. The first meeting of international steam table experts was held in London in 1928 and the second in 1930 at Berlin.

At this conference the results of steam researches that have been completed since 1930 will be presented and discussed. It is hoped that new steam table data will be agreed upon which will reduce the tolerance range, particularly in the critical pressure zone. It is hoped that the maximum tolerance will be reduced to one part in 4,000.

The delegates meet first in Washington, D. C., where they will inspect the

experimental apparatus at the Bureau of Standards. On the following day the Eastman Laboratory of the Massachusetts Institute of Technology will be visited as well as the 1,400-lb. Edgar Station.

Meetings on the remaining four days will be held in New York at the Engineering Societies building. A complimentary dinner is planned for the visiting delegates on Wednesday, Sept. 19, at the Hotel Astor, which all steam engineers have been invited to attend (dinner $5 a plate). Alex Dow, president of the Detroit Edison Co., will preside at the dinner.

Industrial Advertisers to Meet in Cincinnati

The Netherland Plaza Hotel, Cincinnati, will be the scene of the convention of the National Industrial Advertisers Association, Sept. 20 to 22. Mr. McFee of the American Rolling Mill Co. is chairman of the committee. Gregory Starbuck of General Electric Co., is chairman of the program committee.

The program will stress industrial working problems. Under the leadership of Alex. Thomson, Jr., of Champion Coated Paper Co., the most ambitious program of entertainment ever attempted in the history of the organization will be carried out, at no cost to the guests.

Nine Industrial Leaders On ASA Advisory Board

Nine industrial leaders of the nation have been appointed to membership on the Advisory Committee of the American Standards Association. They are: George B. Cortelyou, president, Consolidated Gas Co. (chairman); Samuel L. Avery, chairman, Montgomery Ward & Co.; Lammot duPont, president, E. I. duPont de Nemours & Co., and chairman, General Motors Corp.; Walter B. Gifford, president, A.T. & T. Co.; Henry I. Harriman, president, Chamber of Commerce of U. S. A.; W. A. Irvin, president, U. S. Steel Corp.; James H. McGraw, chairman of the board, McGraw-Hill Publishing Co.; Gerard Swope, president, General Electric Co.; Daniel Willard, president, B.& O. Railroad.

Unit Conditioner Association Formed

A new association to foster and promote unit air conditioners has been formed with these officers: P. A. McKittrick, president (treasurer and general manager, Parks-Cramer Co.); Allston Sargent, vice-president (president, Campbell Metal Window Co.); Harry C. Grubbs, treasurer (sales manager, De La Vergne Engine Co.). John A. Dewhurst has been appointed temporary secretary, with offices at 330 West 42nd St., New York, N. Y. A code of fair trade practices has been filed with NRA and a public hearing held.

PERSONALS

Henry M. Chase, consulting engineer of the Holyoke works of Worthington Pump & Machinery Corp., Harrison, N. J., has retired. He entered the engineering department of the then Deane Steam Pump Co. in 1891, and with the exception of a year spent with De La Vergne Mfg. Co., has been continuously identified with Worthington until his recent resignation. He began as a detail draftsman and worked up to designer, field and shop test engineer, research engineer, estimator, chief draftsman and chief engineer to consulting engineer. He was particularly active in the early days of direct-acting compound and triple-expansion engines, and was a strong factor in forwarding the design and performance of power pumps and in refining the Deane single direct-acting pump steam valve gear.

William Lloyd, for many years identified with the design, manufacture and sales of Coxe stokers, has again become associated with the engineering department of Combustion Engrg. Co., Inc.

Rodney E. Matthews has been appointed district manager of the southern territory for Borden Co., Warren, Ohio.

J. C. Sprague has joined Acheson Colloids Corp. as assistant secretary and treasurer, and will be located in New York.

Ralph C. Harden has been appointed manager of packing sales in the Mechanical Goods Division, U. S. Rubber Co., with offices at 1790 Broadway, New York, N. Y. During the last 15 years he has been with Johns-Manville.

M. S. Palmer, for many years midwestern distrct sales manager of Consolidated Ashcroft Hancock Co., Inc., with headquarters at Chicago, has been made sales manager of its Hancock Valve Division, and will be located at the general sales headquarters in Bridgeport, Conn. C. L. Harris, formerly in charge of the Pittsburgh office, has been made mid-western district sales manager, with headquarters in Chicago. W. F. Loos, formerly sales representative in Dallas, Tex., has been made district sales manager, with headquarters at Pittsburgh.

Thorndike Saville, professor of hydraulic and sanitary engineering, New York University, has been appointed executive engineer in immediate charge of the water resources investigations of the National Resources Board. This Board is making investigations preliminary to an exhaustive report to President Roosevelt on a comprehensive national water resources policy. An inventory of water resources is to be included.

D. D. Morey, formerly of Morey & Morey, Dallas Tex., has been appointed district manager for D. W. Haering & Co., Inc., 3408 Monroe St., Chicago, Ill., in charge of the New York office at 1451 Broadway.

M. J. Czarniecki has been elected vice-president in charge of sales, A. M. Byers Co., to succeed H. W. Rinearson, resigned.

John Hunter, of St. Louis, Mo., has joined Riley Stoker Corp., Worcester, Mass., as advisory engineer. He will devote all of his time to the affairs of Riley Stoker.

Andrew D. Hunt has been appointed manager of engineering of the South Philadelphia Works, Westinghouse Electric & Mfg. Co. He was with Alberger Pump & Condenser Co. from 1910 to 1919, when he joined Westinghouse, with whom he has been continuously since that time. In October, 1932, he became steam service manager of the South Philadelphia Works.

J. J. Richards has been appointed manager of the vibrating screen department, Link-Belt Co., 910 S. Michigan Ave., Chicago., Ill., succeeding Harry L. Strube, who has been promoted to assistant chief engineer at Philadelphia.

Maj. Edwin H. Armstrong, well known in the radio communication field, has been appointed professor of electrical engineering at Columbia University, New York.

Porter H. Adams has been elected president of Norwich, Vt., University. This is one of the oldest engineering colleges in the United States, and Mr. Porter has been acting president of the institution since December, 1933.

G. H. Burkholder, formerly of Philadelphia, has been appointed western sales manager of the Positive Drive Divsion, Link-Belt Co., Chicago, with headquarters at the company's Dodge plant in Indianapolis, Ind. W. H. Kinkead has been made manager of sales of speed reducers, with headquarters in Philadelphia, to succeed Mr. Burkholder. G. L. Gansz succeeds Mr. Kinkead in charge of Philadelphia office sales of the Positive Drive Division.

Bancroft Gherardi, vice-president and chief engineer of American Telephone & Telegraph Co., has been appointed a representatve of the A.I.E.E. on the John Fritz Medal board of award, to succeed the late W. S. Lee.

George J. Lynch, formerly identified with the Eau Claire office of Northern States Power Co., has been appointed manager at Mankato, Minn. A. G. Buchholz, manager at Mankato, has been transferred to Sioux Falls, S. D., as manager, to succeed O. A. Rofelty.

BUSINESS NOTES

Ernest E. Lee Co., Chicago, Ill., has moved to the Monadnock Block, 53 W. Jackson Blvd.

Lewis Air Conditioners, Inc., Minneapolis, Minn., has recently licensed Julian P. Friez & Sons, Inc., Baltimore, Md., and Minneapolis Honeywell Regulator Co., Minneapolis, Minn., to build its air-conditioning systems.

McCormick Asbestos Co., 1400 Moreland Ave., Baltimore, Md., has been appointed agent for Mundet Cork Corp., 450 Seventh Ave., New York, N. Y., in the Baltimore territory.

Sivyer Steel Casting Co., Milwaukee, Wis., has opened a New York office in charge of A. N. Diecks, in Suite 810, 500 Fifth Ave.

Louis Allis Co., Milwaukee, Wis., has moved its Pittsburgh office to 537 Oliver Bldg., and placed it in charge of J. F. Rodgers.

National Motor Bearing Co. has purchased the factory building formerly occupied by the Pacific Coast Division of the R.C.A.-Victor Corp. in Oakland, Calif., and will begin production there about Oct. 1.

Buhls Sons Co., Detroit, Mich., has been appointed distributor for Toncan iron by Republic Steel Corp., Youngstown, Ohio.

Meriam Co., 1955 West 112th St., Cleveland, Ohio, is again expanding its plant, the new building to be used for gas and oil engine rebuilding.

James L. Robertson 3rd, 116 Broad St., New York, N. Y., is now handling the line of steam specialties, including indicators, reducing wheels, tube cleaners, etc., formerly manufactured by James L. Robertson & Sons.

OBITUARIES

George W. Christoph, 71, founder and president of Sterling Blower Co. and Hartford Blower Co., died Aug. 21 after a long illness. In early life he was associated with the New York Exhaust and Blow Pipe Co.

J. R. Cooke, formerly chairman of the Ontario Hydro-Electric Power Commisson, died at his home in Belleville, Ont., Aug. 13 from injuries suffered in an automobile accident.

Joshua R. Johnson, 73, who was associated with the pioneer development of Thomson-Houston Electric Co., at Lynn, Mass., prior to the organization of General Electric, died at St. Petersburg, Fla., Aug. 15. He retired in 1930.

William W. Redmond, New England manager of National Regulator Co., died Aug. 3 at the Leonard Morse Hospital, Natick, Mass., following a short illness.

Dr. Harris J. Ryan, 69, former executive head of the electrical engineering department, Stanford University, past president of the A.I.E.E. and internationally known researcher in the field of high-voltage, long-distance power transmission, died of a heart attack at his home in Palo Alto, Calif., July 4.

Sven Svenningson, 51, chief engineer of Shawinigan Water & Power Co. and the Shawinigan Engineering Co. and vice-president and chief engineer of Power Engineering Co., died at Bailey's Island, Me., Aug. 16. Mr. Svennngson was recognized as one of the outstanding hydro-electric engineers in Canada, where he had made his home for the past 21 years.

STRAWS

Pointing the way business winds blow

Central Valley Project of the State of California is under careful study by the Federal Power Commission for which an application for license under the water power act has been filed. The project provides for the ultimate expenditure of $170,000,000. It involves irrigation as well as the production of power and the control of floods. The application sets forth that the project is in the counties of Shasta, Madera, and Fresno. Kenneth Dam, which it is proposed to erect in the headwaters of the Sacramento River, is to be built to a height of 420 ft. The resulting reservoir would have a capacity of 2,980,000 acre-feet. It is proposed to install at that dam equipment capable of developing 295,000 hp.

Nine miles downstream it is proposed to erect the Keswick Afterboy Dam 95 ft. high. The reservoir there would be of 1,400 acre-feet capacity and would be used for regulating purposes only. It is proposed to install 55,000 hp. at that point. Friant Dam, 252 ft. high, would be built in the San Joaquin River and, according to the application, would create a reservoir of 400,000 acre-feet capacity. The installation at that point would be 35,000 hp.

Gulf Industries, Inc., Pensacola, Fla., plans construction of steam power plant at proposed new shipbuilding and repair works on waterfront, where about 175 acres of land has been secured from City Council. Financing of $2,500,000 being arranged through Federal aid for group of shop buildings, drydocks and other structures. Equipment electric-operated. Frederick Gillimore, Sr., president, and Lawrence R. Wilder, vice-preisdent.

Minnesotans have plans under way for several new municipal electric light and power plants. Citizens at Fairfax have authorized Village Council to have plans drawn and estimates of cost made for new station, using diesel engine-generating units. New Ulm s having surveys and estimates of cost completed by L. A. Breneman, Builders Exchange Bldg., St. Paul, consulting engineer, for proposed extensions and improvements in present municipal plant, including installation of new prime movers and other equipment; Worthington has arranged financing through Federal aid for fund of $29,000, for installation of new turbo-generator unit and accessory equipment in existing station and bids for such equipment will soon be asked. Charles Foster, Sellwood Bldg., Duluth, is consulting engineer. Early in October, bids will be called for a new light and power plant and electrical distribution system at North Mankato, for which plans are being drawn by G. M. Orr & Co., Baker Bldg., Minneapolis, consulting engineers.

Hartford, Wis., is completing plans for extensions and improvements in municipal electric plant, including new turbine unit, and plans early call for bids for equipment. Jerry Donohue Engrg. Co., 608 North Eighth St., Sheboygan, Wis., consulting engineer.

United States Engineer Office, St. Paul, Minn., will receive bids on or about Sept. 18, for construction of Dam No. 6, Mississippi River, near Fountain City, Wis., including roller and taintor gates, service bridge and complete electrical operating equipment, distribution system, lighting and signaling apparatus.

Department of Public Works, Kansas City, Mo., plans early construction of new one and two-story power house, refrigerating plant and mechanical laundry at General City Hospital, 24th and McCoy Sts. Estimated cost close to $300,000, with equipment. A. W. Archer & Co., Pioneer Trust Bldg., city, are architects.

Hiram, Ohio, has plans nearing completion for new municipal light and power plant, using diesel engine-generator unit, and will soon take bids for equipment. Cost about $32,500. R. Husselman, Hippodrome Bldg., Cleveland, Ohio, consulting engineer.

Silver Foam Brewing Co., Canal and West Fortieth Sts., Ballard, Seattle, Wash., plans one-story steam power plant at proposed new three-story brewery on local site. Cost about $200,000, including brewery machinery. James Wilson, company engineer; Henry Bittman, Securities Bldg., Seattle, architect.

Kanawna Valley Power Co., Charleston, W. Va., an interest of Appalachian Electric Power Co., will soon begin construction of proposed new hydro-electric generating plants on the Big Kanawha River, for which Federal permission has recently been secured. Stations will be built on the abutment side of dams constructed by the Government at Lock No. 2, Marmet, W. Va., and Lock No. 3, London, W. Va. A 24-ft. head will be available for power service at the different sites. Each hydro-electric station will comprise three 6,000-kva. waterwheel-generator units, making a gross capacity of 36,000-kva. at the two plants. Contracts for the prime movers were let recently. It is expected to place contracts for other required equipment and complete accessory apparatus at early date. The new plants are scheduled for completion in about 18 months, and are estimated to cost close to $4,000,000. A third hydro-electric generating station will be built soon by the same company at Winfield dam on the Big Kanawha River, near Winfield, W. Va., where the Government has work in progress on twin locks. This station will have an initial rated capacity of 18,000-kva., divided into three 6,000-kva. generating units.

Lincolnton, N. C., and 12 to 15 other towns in that district are planning a cooperative steam-electric light and power plant, to cost $6,500,000, financed by the Federal Government. Towns interested include: Shelby, Kings Mountain, Cherryville, Forest City, Rutherfordton, Maiden, Newton, Hickory, Morganton, Granite Falls and Lenoir. City Attorney W. H. Childs of Lincolnton is heading up the plans.

Miniature waterwheel generator forming part of the Westinghouse exhibit at A Century of Progress, Chicago. 1,600 g.p.m. of water at a pressure comparable to that of the flow from a 15-ft. dam spins the rotor at 400 r.p.m. to produce enough power to light the lamps which illuminate the model

Minnesota Valley Natural Gas Co., Odd Fellows Bldg., St. Peter, Minn., has approved plans for installation of welded steel pipeline from Northfield, Minn., to St. Peter and vicinity, a distance of about 40 mi., for natural gas service. Distribution systems and plants will be constructed for service at Montgomery, Le Center, New Prague, Le Sueur and St. Peter. Project will cost close to $200,000.

Blair Distilling Co., 1820 David Stott Bldg., Detroit, Mich., recently organized under Michigan laws, plans construction of power house at proposed new distilling plant at Chicago, Marion County, Ky., where large tract of land has been acquired. Plans are under way for main multi-story distillery units with smaller buildings, with cost estimated close to $100,000, including equipment. Company has $180,000 financing in progress to provide funds. Thomas J. Nolan, Kentucky Home Life Bldg., Louisville, Ky., architect.

Fairbanks, Morse & Co., Chicago, Ill., have secured a number of contracts recently for diesel engine-generating sets and auxiliary equipment for new municipal light and power plants in Middle West cities. Award for engine-generator sets with switchboard, instruments and accessory equipment, has been secured for new station at Kennett Mo., at contract price of $150,773; 375-hp. engine-generator sets with complete auxiliaries will be furnished for lighting plant at Rockford, Iowa, at cost of $82,961, entire project estimated to cost $105,000; at a contract price of $127,340, prime movers and accessory equipment will be supplied for new plant at California, Mo., and work on this program will proceed at once; Sumner, Iowa, has placed an order with company for engine-generating units and auxiliaries, as well as distributing lines, to cost about $115,000.

Decatur, Ala., has plans maturing for new municipal light and power plant and distribution system, and proposes to proceed with program in the fall. A fund of $350,000 has been secured through Federal aid.

Director of Purchases, Tennessee Valley Authority, New Sprankle Bldg., Knoxville, Tenn., will receive bids until Oct. 8 for furnishing, fabricating and delivering two 66,000-hp. vertical-shaft, plate-steel spiral-scroll-case, single-runner hydraulic turbines for new hydro-electric generating plant at Norris, Tenn.; also, for one 45,000-hp. vertical-shaft, concrete spiral-casing, single automatically adjusted propeller-type-runner hydraulic turbine for hydro-electric power plant at Wheeler Dam.

Springfield, Ill., will receive bids until Sept. 17 for equipment for extensions and improvements in municipal light and power plant, including steam piping, measuring and control instruments and miscellaneous apparatus. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif., has plans maturing for installation of new 12-in. steel pipeline from Kern River oil field district, near Bakersfield, to oil refinery on Estero Bay, San Luis Obispo County, for crude oil supply, about 108 miles. Project will include seven large pumping plants and new storage reservoir at the Estero Bay plant, as well as battery of steel storage tanks and auxiliary equipment. Entire project will cost close to $3,500,000, and will be placed under way early in the fall. H. H. Hall is chief engineer for company.

Cliffside Brewing Co., West McMicken St., Cincinnati, Ohio, will make extensions and improvements in steam power plant, including installation of new boiler, automatic stoker and accessory equipment. Capacity of plant will be increased. Fosdick & Hilmer, Union Trust Bldg., city, engineers.

Torrance, Calif., is concluding negotiations for purchase of local water system from the Torrance Water, Light & Power Co., for $137,000, and will operate as municipal property in the future. Plans are under way for extensions to cost close to $100,000. E. B. Bradshaw & Taylor, 714 West Tenth St., Los Angeles, consulting engineers.

Homestake Mining Co., Guy N. Bjorge, assistant general manager, Lead, S. D., is erecting its Kirk power plant at that place, the estimated cost to be about a million dollars. This will include three 10,000-sq.ft. boilers and room for more, all to be stoker fired.

Rocky Mountain Power Co. has been refused an extension of license on the Flathead power project, by the Federal Power Commission. This put the license in default as of Aug. 24, but six months grace has been extended. The project, on Flathead River and Lake, Mont., was planned for 80,000 primary hp. and eventual installation of 150,000 hp. The original 50-year license was issued in 1930, and the present drastic action is a result of rents due Indians.

St. Hyacinthe, Que., is soon to install the first of the four 600-hp. diesels in its municipal diesel plant. Built by Montreal Locomotve Works, Ltd., this engine is the first such unit to be built in Canada with Canadian labor.

Cleveland Railways Co. has ordered two Westinghouse 750-kw. mercury arc rectifiers, and auxiliary apparatus, switching and transformer equipment for the new Rocky River substation.

Possum Glory substation of Associated Gas & Electric Co. was struck by lightning three weeks ago. The bolt struck one of the nine 15,000-watt transformers, igniting the oil in it. The burning oil spread to the others, destroying six and damaging three, causing more than $100,000 damage, according to Supt. Robert T. Martin.

Lockport, N. Y., has filed an application with the Federal Power Commission for license for a municipal hydro plant and for use of 275 cu.ft. per sec. of Niagara River water. If this water is granted Lockport, it is the last water within the power of the Commission to grant, since Niagara Falls Power Co. is now using all the rest under license, as well as this under temporary license.

Lockport, N. Y., is considering municipal hydro-electric generating plant for light, power and water. Proposed initial capacity 4,400 kw.; location on Eighteen-Mile Creek, with water supply through Barge Canal and new tunnel from Niagara River to that point. Project estimated to cost about $900,000, including transmission lines, financing carried out through Federal aid. Proposition to be placed before voters at next election. Louis A. Harding, Prudential Bldg., Buffalo, N. Y., engineer.

Culpeper, Va., opened its municipal electric light and power plant officially Aug. 1.

NEW BULLETINS

Torque-Limiting Valve Operator—Philadelphia Gear Works, Philadelphia Limitorque Division, Erie Ave. & "G" St., Philadelphia, Pa. 30-page catalog on "Limitorque Control" valves described on page 102 of *Power* for February. Describes complete control, elements, limit mechanism and torque and geared limit switches, control stations, various valve arrangements, etc., in attractive form. Also operating chart and specifications.

Portable Instruments — Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa. Cat. Sec. 43-120 describes new Px-5 portable instruments of high-accuracy type. 6-pages, application, construction, operation, prices.

Material-Handling Equipment — Robins Conveying Belt Co., 15 Park Row, New York, N. Y. Three new bulletins. 8-page No. 89 describes "Gyraloy" and "Super-Gyraloy" screen cloth. 24-page No. 90 describes "Gyrex" screens for coke-screening, etc. 8-page No. 91, "The Chance Sand-Flotation Process for Cleaning Bituminous Coal."

Refractory—Johns-Manville, 22 E. 40th St., New York, N. Y. 4-page folder IN-27-A on use of "Sil-O-Cel." C-22 brick as combination refractory and insulation for temperatures up to 2,000 deg. F. Engineering information, conductivity, strength, permeability, etc.

Power Transmission—Flexible Steel Lacing Co., 4607-31 Lexington St., Chicago, Ill. 72-page illustrated text, "Short Cuts to Power Transmission," a revision of an older book with new chapters added. Information for solving ordinary belt transmission problems, discussion of belting, belt joints, etc.

Induction Motors—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Leaflet 2173, "Squirrel-Cage Induction Motors, Type AR," 4 pages, illustrated.

Tramrail—Cleveland Tramrail, Division of Cleveland Crane & Engineering Co., Wickliffe, Ohio. Form G-234, four-page bulletin, "Has a Cleveland Tramrail Man Shown You?" showing methods of transporting materials within the plant.

Rotary Switches—Roller Smith Co., 233 Broadway, New York, N. Y. Eight-page catalog No. 9, describing "Type R Rotary Switches" for either instrument or control work, includes specifications, connection diagrams, etc.

Safety Stair Treads—Norton Co., Worcester, Mass. 12-page Form 1604 describes "Alundum" rubber-bonded safety treads for stairs, etc.

Refractory Concrete—The Denver Fire Clay Co., P. O. Box 1107, Denver, Colo. Eight-page Bulletin 147, "Hi-Cast Refractory Concrete," describes new method of applying refractories, which permits refractory actually to be cast on the job just as concrete is cast.

Motoreducers — The Falk Corp., Milwaukee, Wis. Six-page Bulletin 271 describing vertical motoreducers, which are a new addition to the horizontal motoreducers and horizontal right-angle and vertical speed reducers.

Bearing Bronze — Magnolia Metal Co., 120 Bayway, Elizabeth, N. J. Four-page size and weight list of Magnolia bearing-bronze bushings, semi-finished outside or inside in 12-, 13- and 14-in. lengths.

Boiler Setting Cement — Everseal Mfg. Co., Inc., Fisk Bldg., Broadway at 57th St., New York, N. Y. Four-page Form 117 describing Everseal boiler setting cement available in steel drums of 600 lb. or half drums of 400 lb.

Lubricating Ball Bearings—Acheson Colloids Corp., Port Huron, Mich. Four-page Technical Bulletin 182P, concerning the use of "Colloidal-Graphited Lubricants in Ball Bearings," is the result of a test conducted at the National Physical Laboratory in England for this company's British affiliate. Shows advantages of colloidal graphited oil for this service.

Waste Heat Boilers — Foster-Wheeler Corp., 165 Broadway, New York, N. Y. 12-page Bulletin WHB-34-1, "Waste Heat Boilers and Water Heaters," describes various applications of muffler boilers on diesel engines, natural gas engines and blast-furnace gas engines. Values from 90 to 7,000 hp. Units described are of extended service, armored type. Waste-heat water heaters are also described, used for heating process or service water with heat in exhaust gases of internal combustion engines.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Sacramento—Sacramento Calif. Valley and Dist. making plans power plant and electric distribution system. $20,000,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Colorado—Bids Oct. 10, by Bu. of Reclamation, Denver, furnishing 2,300 v. switching equipment; 4 287-5 kw., 3 cycle oil circuit breakers; outdoor type lightning arresters; twelve 287-5 kw., 1,200 amp., 3 pole, motor operated dismounting switches; one 4,000 amp. and one 2,000 amp. 23,000 v. bus structure with current transformers; four 600 amp. 15,000 v. oil circuit breakers, etc., for Boulder power plant, Boulder Canyon Project.

Ga., Augusta — Augusta Canal Comn., A. Merry, chn., revising plans for hydro-electric plant to meet P.W.A. allotment and eliminate contracting with private company to furnish stand-by power. New plan consists of both hydro and auxiliary combustion engine plants. Est. $1,250,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Ill., Centralia—City election about Oct. 17, for proposal to construct, maintain and operate a municipal light and power plant. $477,000. P.W.A. allotted $117,000 grant and $360,000 loan. Plans issuing $360,000 in public utility certificates to be used as collateral for P.W.A. loan. Baumes-McDevitt Co., 1871 Railway Exch. Bldg., St. Louis, engrs.

Ill., Naperville—City plans altering and additions to power generating plant, incl. electrical equipment, two 500 hp. diesel engines, $80,700. Allen & Vogtborg, 205 West Wacker Dr., Chicago, engrs.

Ill., Peoria—Bids Sept. 15 (extended date), by Bd. Trustees, Greater Peoria Sanitary and Sewage Dist., Peoria Co., for gas power plant and appurtenances. Greeley & Hansen, 6 North Michigan Ave., Chicago, engrs.

Ill., Springfield—Bids Sept. 17, by City, piping for new power plant at Lake Springfield, 217 different lines. Plans boiler combustion control equipment for new power plant (no date set for bids). Burns & McDonnell, Kansas City, Mo., engrs.

Ia., Glidden—Bids Sept. 19, by City Council, building and equipment, diesel engine electrical generating system, incl. cooling tower base, oil tanks, 2 units diesel electrical generating equipment, 2 generators, switchboard, bus structure, cable and wiring. $47,500. Young & Stanley, Inc., Muscatine, engrs.

Ia., Sioux City—Iowa Supreme Court issued a temporary restraining order, preventing Sioux City from holding election on proposal for constructing, maintaining, operating municipal light and power plant. $2,500,000 bonds were to be issued and rest of cost obtained by P.W.A. loan. Total cost $3,612,500.

Me., Millinocket—Great Northern Paper Co. plans power plant, $80,000. H. J. Deutchbein Co., 350 Fifth Ave., New York, engrs.

Md., Baltimore—Gas & Electric Co., Lexington Bldg., plans 2 story, 60x80 ft. electric substation. Est. $50,000. A. D. Loizeaux, Monument and Constitution Sts., engrs.

Mich., Allegan—City plans 2 story, basement, brick, rein.-con. and steel power plant, plain found. Est. $410,000. P.W.A. loan and grant approved. Injunction restraining city from proceeding with power plant project has been lifted. Ayres, Lewis, Norris & May, Cornwall Bldg., Ann Arbor, engrs.

Mich., Morenci—Village plans power plant. $146,000 P.W.A. allotment. G. C. Dailey, Morenci, engr.

Minn., Fairfax—Municipality plans electric power plant. To exceed $60,000.

Minn., Milaca and Pine City—Eastern Minneapolis Power Co., Pine City, altering electric power plant and distribution lines, day labor. $30,000.

Miss., Jackson—City plans power plant. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Mo., Moberly—City indefinitely postponed constructing light and power plant addition, two 2,000 kw. turbo-generators, electric distribution system, etc. $700,000 P.W.A. grant and loan rescinded. Russell & Axon, 4903 Delmar Blvd., St. Louis, engrs.

Mo., Perry—City election soon to vote bonds diesel engine power plant. $50,000. W. B. Rollins & Co., 339 Railway Exch. Bldg., Kansas City, engrs.

Mo., St. Charles—City, rejected application $350,000 P.W.A. loan and grant for light and power plant. Russell & Axon, 4903 Delmar Blvd., St. Louis, engrs.

N. Y., Elmira—Bids Sept. 20, by Commissioner Correction, State Office Bldg., Albany, construction, heating, sanitary, electrical work, and coal handling apparatus for power house and service connections, at Elmira State Reformatory. $540,000. P.W.A. loan $162,000.

N. Y., Lockport—City, H. F. Thurston, mayor, election in November, on bonds for municipal hydro electric plant. $908,000. P.W.A. project. L. A. Harding, Prudence Bldg., Buffalo, engr.

N. Y., Ovid—New York State Electric & Gas Corp., Ithaca, plans electric plant and power lines here and in Seneca Co. $25,000 or more.

N. Y., Rockville Center—Dpt. P. Utilities, plans power plant addition. $200,000. P.W.A. funds allotted. H. C. Major, engr.

N. Y., Sherburne—Utica Knitting Co. plans power plant addition. Private plans.

N. Y., Somers—New York State Electric & Gas Corp., Ithaca, will build electric power plant, here, by separate contracts and day labor. To exceed $28,500. Public Service Comn. authorized project.

N. Y., Wellsville—Municipality plans electric power plant. $85,000 P.W.A. funds allotted. E. J. Rowe, 110 Maple St., Wellsville, engr.

O., Akron—City, municipal light plant reports nearing completion, will start plans in near future. Est. $3,000,000. Burns & McDonnell Engineers Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Pa., Ambridge—Borough Council, plans being revived for construction municipal electric light and power plant. To exceed $75,000.

Pa., Coraopolis—Municipality plans electric power plant. P. F. Loftus, Oliver Bldg., Pittsburgh, engr.

Pa., Emaus — Boro, Boro Hall, plans constructing power plant and transmission line. $265,000. Will authorize bond issue after approval by Boro.

Pa., Indiana—Associated Gas & Electric Co., 61 Bway., New York, plans electric power substation (Possum Glory Sub-station). $100,000.

Tenn., Knoxville—Bids Oct. 8, by Tennessee Valley Authority, hydraulic turbines for Norris power plant and Wheeler power plant. C. H. Garity, Dir. of Purchases.

Tex., Kennedy—City, c/o E. P. Ruhman, voted $161,000 bonds, municipal light plant. P.W.A. project.

Wash., Pullman — Bids Sept. 4, by Bd. Regents, Washington State College, Pullman, 1 story, 60x100 ft., power house and equipment, campus. $260,000. Stanley & Smith, Pullman, engrs.

Wash., Seattle—Bids Sept. 13, by Bd. Pub. Wks., County-City Bldg., Construction of power house building, transformer and switch platform, etc. Est. about $100,000. Specifications covering electrical apparatus needed for Diablo power house on Skagit River approved and bids called, est. $200,000.

N. B., Fredericton—New Brunswick Electric Power Comn., making plans extensions in Northumberland Co. $451,650.

Que., Noranda — Noranda Mines Ltd. plans 20,000 hp. hydro-electric power development on upper Ottawa or Victoria River. F. Gaby, Toronto, Ont., consult. engr.

Azores, Ponta Delgada—Bids Nov. 5, by Clerk of Municipality, supplying hydro-electric plant, incl. 1 Francis turbine about 450 hp.; one 3 phase alternator; 1 oil cooled transformer, switchgear, etc.

Uruguay, Montevideo—Bids Jan. 15, by Ministry of Public Works, hydro-electric development on Rio Negro. Plans and specifications may be obtained from nearest legation or consulate. Tenders to be in Spanish. Work to commence not later than June 1, 1935.

Egypt, Cairo—Bids Oct. 18, by Director General, Mechanical and Electrical Dpt., Ministry of P. Wks., supplying and erecting in Northern Nile delta, 3 complete electrical pumping stations, complete with buildings, machinery, etc. Plans, etc., can be obtained at Royal Egyptian Legation, Wash., D. C.